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John Adam House

January, 1921, saw the first weekly issue of the FOUNDRY TRADE JOURNAL. It was published from Bessemer House, Adelphi, London, W.C.2, and upon this site, which was bombed during the war, there has risen a magnificent, modern, yet dignified, building—John Adam House—our new home. The return, after 28 years in Covent Garden, marks a milestone of some significance, because it will enable a still better service to be given to readers, advertisers and the associations of which we are so proudly the official organ. The new building obviously affords the staff better working conditions, as much thought has been given to heating, lighting, ventilation, and canteen facilities. A conference room is available for committee meetings and reception offices are made available for visitors. Perhaps the major improvement is the considerable extension to the drawing office, for it is this department which can be a potential "bottleneck" in any publishing organization.

The office of the FOUNDRY TRADE JOURNAL has always been the industry's information centre. It has been visited by many of the great leaders of the industry, both home and overseas, for the last 50 years or more. Yet not all callers were well known and affluent, there were some desperately in need of a job, others desired advice as to the development of their sometimes sensible and sometimes quite unworkable inventions. It is our belief and hope that no-one went away feeling that their time had been wasted. Thus, a record of service has been built up which cannot help but be enhanced, not only by the facilities of a modern building, but by the vast store of information that has been accumulated over such a long period. In the early days, we were the sole source for enquiry on foundry matters, but nowadays, with the very extensive development of the industry, involving as it does the creation of specialized bureaux, we have the additional advantage of being not only a centre but also a clearing house.

When people move to a new and larger house, they tend to acquire new interests and enlarge their circle of friendships. This we hope will be our experience. Recent new interests have included the various types of precision methods of making castings and undoubtedly there will be many more to come, for invention breeds invention. As for new friendships, our ever-increasing circulation assures us that John Adam House will be a major attraction for foundrymen. An invitation is extended to all founders to call when in town to tell us of their problems, to discuss policies, and to cement those ties which bind us so closely to the industry we serve, for it is only by these personal contacts that public opinion can be assessed and expressed.

A.E.I. Reorganization

The Board have decided to reorganize the A.E.I. Companies into four groups: B.T.H.; Ediswan-Hotpoint; M-V.E.; and Overseas. The reorganization, and all consequent appointments, take effect from October 11.

Group Chairmen and Managing Directors:—

The chairman of A.E.I. becomes chairman of each of the groups and the following are group managing directors: B.T.H.: Mr. E. H. Ball; Ediswan-Hotpoint: Mr. A. N. E. McHaffie; M-V.E.: Dr. C. Dannatt, and Overseas: Dr. I. R. Cox. The group managing directors are members of the A.E.I. Board (Dr. Dannatt and Mr. McHaffie have been appointed directors from October 1), and form, with the chairman, the executive committee of the Board.

The managing director of the Overseas group will be the A.E.I. nominee director on the Boards of A.G.E., First Electric and Vecor, and will become chairman of A.E.I. (India) and A.E.I. (Pakistan). The B.T.H. and M-V.E. export companies will operate as at present. To ensure the closest liaison, however, the managing director of the Overseas group has become chairman of the B.T.H. and M-V.E. export companies. As part of the reorganization, Mr. G. A. Cheetham, managing director of Ferguson Pailin, joins the Board of Metropolitan-Vickers; he continues as managing director of Ferguson Pailin.

Labour Relations in the Steel Industry

In his speech at the opening of the fifth session of the Iron and Steel Committee of the International Labour Organization at Geneva recently, Mr. Luis Alvarado, assistant director-general of the I.L.O., said that an effort toward understanding and collaboration on the part of employers and workers in the iron and steel industry was more necessary than ever. The year 1954 had been marked by a reduction in the labour force in the industry as a result of modernization programmes and economic events. The imperative need for job security, a need inherent in the conditions of the workers, influenced in large measure the scope of collective bargaining and the demands of the workers' organizations. The demand for certain applications of the guaranteed wage, for example, reflected this need for security. The question of the reduction of working hours had been raised by certain unions.

Mr. Alvarado recalled that Mr. David A. Morse, director-general of the I.L.O., had announced recently that the I.L.O. intended to accord priority to the central problem of relations between the workers and management. The question of "human relations" in the iron and steel industry is on the agenda of the present session of the Iron and Steel Committee.

Light-alloy Air Reservoirs

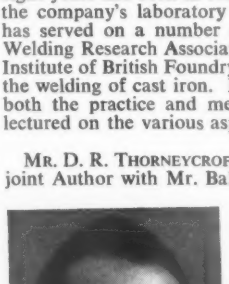
With a view to saving weight and increasing durability, investigations have been proceeding for over two years into the development and manufacture of light-alloy reservoirs, and as a result of co-operation between the Metropolitan-Vickers Electrical Company, Limited, Westinghouse Brake & Signal Company, Limited, and James Booth & Company, Limited, of Birmingham, an aluminium-alloy air reservoir is being installed in the braking system of a Metropolitan-Vickers gas-turbine locomotive to undergo service trials. Furthermore, Metropolitan-Vickers is to instal another of these light-alloy reservoirs on one of its own Diesel-electric shunting locomotives in order to permit day-to-day observation of performance.

Conference Paper Authors

MR. F. A. BALL, joint Author of the Paper "Metallic-arc Welding of Spheroidal-graphite Cast Iron," printed in this issue, joined the Mond Nickel Company, Limited in 1930. He studied part time at the College of Technology, Birmingham, gaining an external London University honours degree in metallurgy. During this period he gained the City & Guilds silver medals in ferrous and non-ferrous metallurgy, and in 1938 he was awarded the Thomas Turner bronze medal by the University of Birmingham.

Appointed to the senior research staff of his company in 1936, he was concerned primarily with investigation on welding and joining, both of ferrous and non-ferrous materials and for the past eight years has been in charge of the research section in the company's laboratory handling these matters. He has served on a number of committees of the British Welding Research Association, and was a member of the Institute of British Foundrymen's committee dealing with the welding of cast iron. He is the author of papers on both the practice and metallurgy of welding, and has lectured on the various aspects of this field.

MR. D. R. THORNEYCROFT, B.Sc., A.I.M., A.C.T.(Birm.) joint Author with Mr. Ball was educated at the Central Grammar School, Birmingham. He joined the Mond Nickel Company, Limited in 1939 as an assistant in the Birmingham laboratory and during the war years studied engineering and metallurgy at the College of Technology. He was awarded an external honours degree of the University of London in Metallurgy in 1944, and was appointed to the senior research staff of the company in that year. During the next five years, he gained research experience in several fields, including that of powder metallurgy. He is now engaged on research in the ferrous and non-ferrous field of welding metallurgy.



Scientific Research at Nancy

An international symposium took place at the University of Nancy on October 11 to 15, and was organized by the European Productivity Agency of the O.E.E.C. and the Rector of the University of Nancy, who acted as secretary-general, with the assistance of the French Ministry of Industry and Commerce. It followed up a first international study session convened by the O.E.E.C. in London in November, 1952, as the result of a technical assistance mission which studied the organization of research in Europe. The aim of the symposium was to enable representatives of government bodies, university teachers and European industrialists to study the progress achieved by member countries in the administration and organization of scientific research, and means of developing co-operation for the furtherance of applied research between national bodies, industries, and higher educational establishments.

Metallic-arc Welding of Spheroidal-graphite Cast Iron*

By F. A. Ball, B.Sc., A.C.T. (B'ham) and D. R. Thorneycroft, B.Sc., A.C.T. (B'ham), A.I.M.

Before the full potentialities of spheroidal-graphite cast iron can be realized it will be necessary to develop welding procedures which enable joints to be completed having properties comparable with those of the new material. The present paper describes the mechanical properties of joints prepared by metallic-arc welding using nickel/iron and aluminium-bronze electrodes, and the results of a detailed analysis of the structures of both the weld metal and the adjacent cast iron. The relationship between the properties and the microstructures and how these are affected by heat-treatment has also been examined. The application of the procedures developed during this investigation are discussed for the welding of spheroidal-graphite cast iron in both the pearlitic and in the ferritic conditions.

Introduction

Spheroidal-graphite cast iron is the most recent achievement of the iron founder and its properties and uses have been discussed in the literature of the Institute[1] and elsewhere in detail. The new iron possesses, in both the cast and in the annealed conditions, a combination of strength and ductility which, as is well known, markedly excels that obtainable in flake-graphite iron of similar matrix structure. At least two recent papers[2, 3] have dealt with the welding of s.-g. cast iron, and the author of a third paper[4] has emphasized that the welding of this material would have to be studied thoroughly in the near future.

The welding of flake-graphite grey cast iron has always been considered primarily from the standpoint of the reclamation and repair of unsound or damaged castings: the Institute of British Foundrymen has dealt with this matter in committee[5] and the subject was reviewed by one of the present authors at the annual meeting of the International Committee of Foundry Technical Associations[6] in 1953. It is, however, probable that the new iron will be used on an increasing scale in the field of general and constructional engineering and its usefulness for fabrication purposes will be further enhanced if component parts can be joined by a welding process. The attainment of this object may call for the development of new welding techniques and welding materials, since the unique properties of the s.-g. cast iron will not be fully realized unless the strength and ductility of the welded joint approach those of the parent material. In the Authors' opinion, the metallic-arc welding process offered the most likely means of achieving this objective, provided suitable electrodes could be found. Compared with flake-graphite iron, it appeared that the ductility of the s.-g. iron would contribute to its weldability, as would the lower sulphur and phosphorus contents of the new material.

Of the electrodes available those with nickel-alloy core wires, which find extensive use in the welding of flake-graphite iron, were first examined, and preliminary tests indicated that the nickel/iron electrode was the one which should be studied in detail. This electrode deposits a graphitic nickel/iron weld metal, and is the most recently developed electrode for the welding of grey cast iron. The British version of this electrode became commercially available about the beginning of 1953.

A series of tests was put in hand to determine the optimum welding procedures for the preparation of butt-joints with these electrodes, and to obtain data on the mechanical properties and machining characteristics of the joints so made. For reasons which will be given later, this schedule was subsequently extended to include the examination of joints made with an aluminium-bronze electrode.

A study was also made of the metallurgical changes which s.-g. cast iron undergoes as the result of welding and how these changes, together with the mechanical properties and the machining characteristics of the welded joints, are affected by subsequent heat-treatment. This Paper presents an account of the testing procedures adopted and the results obtained, in the examination of joints welded with the nickel/iron and aluminium-bronze electrodes.

Preparation and Examination of Nickel/Iron Welded Joints

Welding Tests.—A quantity of s.-g. cast-iron plates, 6 in. by 4 in. by ½ in. and 12 in. by 5 in. by 1¼ in., these latter being cut in half to give 6 in. lengths, was prepared by magnesium treatment for these tests: the batches of plates had analyses within the ranges shown in Table I. As cast, these plates had the usual pearlitic microstructure. Plates of both thicknesses were given a ferritizing treatment, and for all welding tests plates in both the pearlitic and ferritic conditions were used.

Two types of joints, illustrated in Fig. 1, were prepared for the majority of tests, a single-vee butt-joint in ½-in. thick plates, and a double-vee butt-joint in 1-in. thick plates. The cast plates were machined on both faces, to reduce them to these thicknesses, and the edges were prepared to angles of 37½ deg., giving an included angle, between the

* Paper presented at the fifty-first annual meeting of the Institute of British Foundrymen, held in Glasgow.

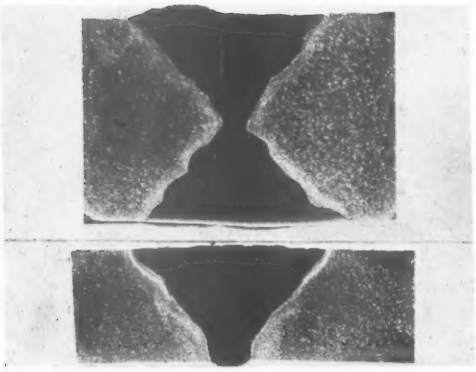


FIG. 1.—*Two joints in pearlitic s.-g. iron plate.* (× 1½.)

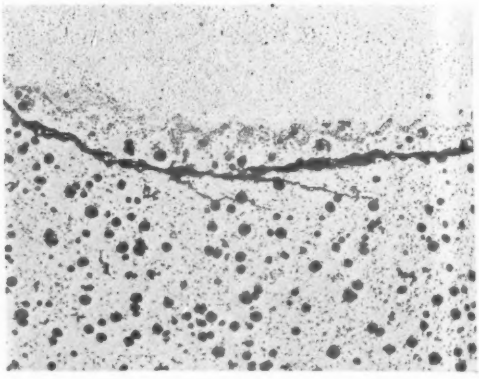


FIG. 2.—*Cracking in un-preheated pearlitic iron plate.* (× 25.)

abutting plates, of 75 deg. Some of the ½-in. plates and all the 1-in. plates were welded without external restraint.

For the unrestrained tests, the machined plates were positioned with a root gap 0.005 in. at the starting end, increasing to 0.020 in. at the finishing end in the ½-in. thick plates. The corresponding values for the 1-in. thick plates were 0.05 and 0.075 in. After positioning, the joints were tack-welded at the finishing end. In addition, the ½-in. thick plates were offset by three degrees, to obtain a flat test-plate when the joint was complete.

Before welding, all the nickel/iron electrodes were dried at 115 deg. C. Alternating current was chosen, as it gave easier deposition and a smoother deposit than was obtainable with direct current, and 10-gauge electrodes, deposited with a current of 85 amp., were used for all root runs and 8-gauge electrodes with a current of 120 amp. for all subsequent runs. Slight weaving was used in the runs toward the top of each joint. The welding of the 1-in. thick plates, after deposition of the root runs, was continued by the deposition of runs alternately on each side of the joint. All the welding was carried out in the downhand position, at a speed of 5 to 6 in. per minute.

Preliminary tests indicated that the ferritic plates could be welded at 30 deg. C. without cracking, but that pre-heating to 200 deg. C. was needed to give crack-free joints in the pearlitic plates. The cracking in the pearlitic plates welded without pre-heating occurred in the heat-affected zone of the cast iron, as shown in Fig. 2.

When welding the ferritic plates the welding heat was allowed to diffuse from the weld between passes so that the overall temperature was substantially even, ultimately reaching about 200 deg. C. It was intended that the temperature of the pre-heated pearlitic plates should not exceed 200 deg. C. at the start of each weld run, and so the plates were allowed to cool to this temperature between passes. After welding, the ferritic plates were allowed to cool freely in air. In the first few tests, the pearlitic plates were covered with asbestos but in later tests it was found that this precaution against cracking on cooling was unnecessary.

Restraint was applied to ½-in. plates by clamping them firmly to the smooth face of the 2-in. thick welding-bench top, leaving a uniform root gap of 0.005 in. between the bevelled edges. The welding procedure was that used for the unrestrained plates, and under these conditions it was possible to produce crack-free joints in ferritic plates welded at 30 deg. C. and in the pearlitic plates pre-heated to 200 deg. C. Freedom from cracking was established in these and in previous tests by visual inspection during and after welding, and by micro-examination of transverse sections cut from several positions in the length of the weld.

The welded plates were then sectioned, the 1-in. thick plates to give tensile test-pieces and the ½-in. thick plates to give bend and impact test-pieces, and sections of all the joints were prepared for microscopical examination. Certain of these were heat-treated as indicated in the tables of mechanical properties. The two-stage heat-treatments were determined from trials as being those which would ensure that the whole of the cast iron, including the zones originally affected by the welding, was in the fully-ferritic condition. It was thought that single treatments for relatively short times at 550, 600 or 700 deg. C. might have beneficial effects

TABLE I.—*Composition of the Spheroidal-graphite Cast Irons Investigated.*

	Range of analyses, per cent.						
T. C.	Si.	Mn.	S.	P.	Mg.	Ni.	Ti.
3.19 to 3.26	2.1 to 2.9	0.26 to 0.31	0.006 to 0.019	0.027 to 0.044	0.042 to 0.081	0.82 to 0.94	0.036 to 0.050

TABLE II.—*Tensile Properties of Welded Joints in 1-in. thick Plate of S.-g Cast Iron (Nickel/Iron Electrode). Test-piece = 0.505-in. diam.*

Initial plate structure.	Condition of plate.	Yield point t.s.i.	Ultimate tensile strength t.s.i.	Elongation on 2-in. per cent.	Reduction of area per cent.	Position of fracture.
Pearlitic	Unwelded	33.3	44.0	3	nil	—
	As-welded	34.0	36.7	2	4	Weld junction.
		n.d.	29.6	1	3	Weld junction/weld metal.
		31.8	36.4	1	3	Weld junction.
	Welded + 2 hr./550 deg. C. ...	n.d.	28.0	1	4	Weld junction/weld metal.
		n.d.	29.1	2	6	Weld junction/weld metal.
		26.0	31.8	2	2	Weld junction.
	Welded + 3 hr./900 deg. C. + 16 hr./700 deg. C.	22.6	27.1	7	9	Weld metal.
		22.3	28.8	12	15	Plate.
		21.9	25.3	6	7	Weld metal/weld junction.
Ferritic	Unwelded	21.2*	30.5*	18	23	—
	As-welded	25.2	30.5	4	16	Plate.
		23.9	28.4	7	11	Weld metal.
	Welded + 2 hr./600 deg. C. ...	22.0	30.1	13	14	Plate.
		16.5	29.2	9	7	Weld metal/weld junction
		22.5	28.5	6	5	Weld metal/plate.
	Welded + 8 hr./700 deg. C. ...	25.4	30.8	11	8	Weld junction.
		25.2	28.3	7	6	Weld junction/weld metal.
		25.4	27.6	5	7	Weld junction/weld metal.
	Welded + 2 hr./850 deg. C. + 8 hr./700 deg. C.	22.5	30.3	6	3	Weld junction/weld metal.
		17.4	29.8	7	5	Weld junction/weld metal

n.d. = not determined. * = Dia. of test-piece = 0.252-in.

on the mechanical properties of the welded plates, and in consequence these heat-treatments also were examined. In addition, all-weld-metal deposits were made with the nickel/iron electrodes from which tensile and impact test-pieces were machined.

Mechanical Tests

Tensile properties.—The tensile properties of the welded joints were determined on 0.505-in. diameter test-pieces machined with the joint centrally positioned across the parallel portion. The results are presented in Table II, which also includes those obtained for unwelded plate.

The tensile strength of the as-welded joint in the pearlitic material did not reach that of the parent plate. Heating of the welded joint at 550 deg. C. for two hours reduced the tensile strength to 28-32 tons per square inch, without materially affecting the ductility. The full-ferritizing treatment further reduced the tensile strength, but improved the ductility. On the other hand, the yield and tensile strengths of the welded joint in ferritic material were similar to those of the parent plate and were not affected by heat-treatment. The ductility of the welded ferritic plates was, under all conditions, lower than that of the unwelded material. The tensile test-pieces from the welded plates broke at the weld junction or in the weld metal, except in the three cases of ferritic test-pieces, which fractured in the plate, as detailed in Table II. A selection of broken test-pieces illustrating the different positions of failure is shown in Fig. 3.

These results show that the tensile properties obtained as the result of ferritizing a welded joint, in either pearlitic or ferritic material, are similar, but the joints have a somewhat lower ductility than that of the unwelded ferritic material. In examining the results of these tests it is of interest to note the properties obtained on all-weld-metal test-pieces (Table III). As this table shows, yield and

FIG. 3.—*Fractured tensile test-pieces from welded pearlitic iron plate: (a) (top) and (b) full ferritized (c) (bottom) as-welded.* (× ½.)

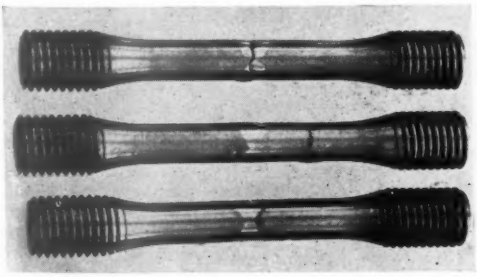


FIG. 4.—*Fractured bend test-piece from welded ferritic iron plate post heated for 2 hr. at 600 deg. C. (Actual size.)*

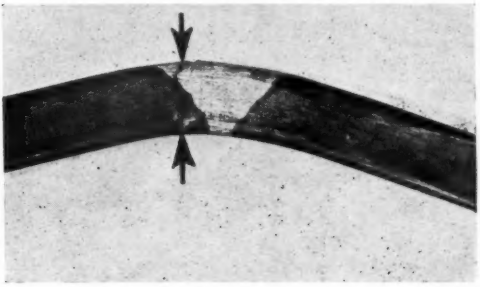


TABLE III.—*Mechanical Properties of All-weld-metal Deposits from a Nickel/Iron Electrode.*

Condition of weld metal.	Mechanical properties.						
	Yield point, t.s.i.	Ultimate tensile strength t.s.i.	Elongation on		Reduction of area, per cent.	Brinell hardness number.	Unnotched Charpy impact strength at 25 deg. C., ft.-lb.
			½ in.	1½ in.*			
As deposited	20.1	30.8	n.d.	n.d.	n.d.	180	78
	19.4	33.8	6	n.d.	11	—	72
	28.0	37.6	12	9	9	—	—
	27.0	36.3	12	7	13	—	—
Heat-treated	30.0	35.0	10	7	14	—	—
2 hr./850 deg. C. + 8 hr./700 deg. C.	27.4	35.2	n.d.	6	9	200	—
8 hr./700 deg. C.	—	—	—	—	—	200	110

* Gauge length = $4\sqrt{A}$. Note: Diameter of tensile test-piece = 0.425 in. n.d. = not determined.

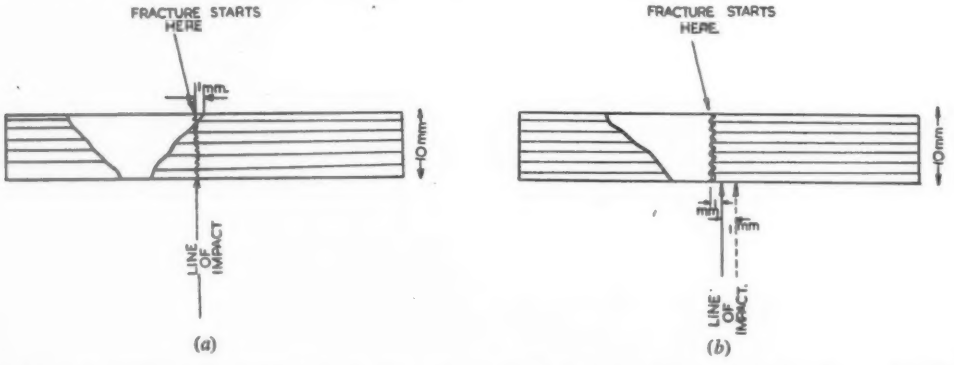
tensile values up to 30.0 and 37.6 tons per square inch, respectively, were obtained. These values were generally greater than those in the unwelded ferritic plates and were unaffected by heat-treatment, but the nickel/iron deposit was less ductile, as measured by values of percentage elongation and reduction of area. The properties of the all-weld-metal deposit may not be exactly those of the weld metal in a normal joint, since the chemical composition of the weld metal depends on the degree of dilution from the s.-g. iron. An analysis of weld metal taken from near the surface of the weld in a single-vee butt-joint was as follows:—

	Per cent.		Per cent.
Carbon	.. 1.30	Titanium	.. 0.22
Silicon	.. 0.3	Sulphur	.. 0.006
Manganese	.. 0.32	Iron	.. 43.8
Magnesium	.. 0.010	Nickel (by difference)	.. 54.0

The carbon content of the weld metal in the root run was somewhat higher, generally about 1.6 per cent. but the nickel content was reduced by dilution to 41 per cent.

Bend properties.—Bend tests were made on strips 1 in. wide cut from the ½-in. plates with the joints centrally positioned across the 6-in. length. The surfaces were ground after removing the reinforcement and the edges were slightly radiused. The support-roller centres were 5 in. apart and the 1-in. diameter former was positioned on the centre line of the weld. Tests were carried out with the load applied to the root and to the face of the weld. The load on the test-piece, together with the angle of bend at fracture, are given in Table IV.

FIG. 5 (*a*) AND (*b*).—*Positions of impact and fracture in Charpy test-pieces from welded s.-g. iron plate.*



When the load was applied to the face of the weld distinctly lower bend angles and lower loads to fracture were obtained. Further comment on bend properties is confined to the results obtained when the load was applied to the root of the weld. The full-ferritizing treatment was necessary to give the maximum angle of bend values (38 to 45 deg.) for the welded joints, in both the pearlitic and ferritic plates, which were, however, up to 42 deg. below the angle of bend values obtained for unwelded ferritic material. The bend properties obtained when joints in both pearlitic and ferritic material had been given the full-ferritizing treatment were similar. Welding did not significantly alter the bend properties of the pearlitic plate, but heating the welded joints at 550 deg. C. for two hrs. reduced the load-to-fracture from 3 to 2 tons. The loads required to fracture the welded and the

TABLE IV.—*Bend-test Properties of Welded Joints in ½-in. thick S.-g. Cast-iron Plates. (Nickel/Iron Electrode.)*

Initial plate structure.	Condition of plate.	Point of application of load.*	Load to fracture, tons.	Angle of bend, degrees.
Pearlitic ...	Unwelded ...	—	3.0 3.0	5 10
	As-welded ...	Weld root	3.0 3.0	14 15
	Welded plus 2 hr./ 550 deg. C.	Weld root	2.1 2.0	13 13
		Weld face	1.7	9
	Welded plus 3 hr./ 900 deg. C. plus 16 hr./700 deg. C.	Weld root	2.0 2.2 2.0	42 44 38
Ferritic ...	Unwelded ...	—	2.3 2.3	78 80
	As-welded ...	Weld root	2.0 2.0	28 25
		Weld face	1.9 1.8	23 14
	Welded plus 2 hr./ 600 deg. C.	Weld root	1.9 2.0	36 38
		Weld face	1.7	18
	Welded plus 8 hr./ 700 deg. C.	Weld root	2.1 2.1 2.0	34 36 31
	Welded plus 2 hr./ 850 deg. C. plus 8 hr./700 deg. C.	Weld root	1.9 2.0	40 45

* In line with the axis of the weld.

unwelded ferritic plates were similar and were not influenced by heat-treatment, but the values for the angle of bend of the as-welded joints (25 to 28 deg.) were increased to a maximum of 38 deg. by treatments at 600 deg. C. for 2 hrs. and at 700 deg. C. for 8 hrs. When the load was applied to the root of the weld the facture started at or near the weld junction in all the bend test-pieces and continued across the plate material, as illustrated in Fig. 4. When the load was applied to the face of the weld the fracture started at one of the weld junctions and then usually continued across the weld metal.

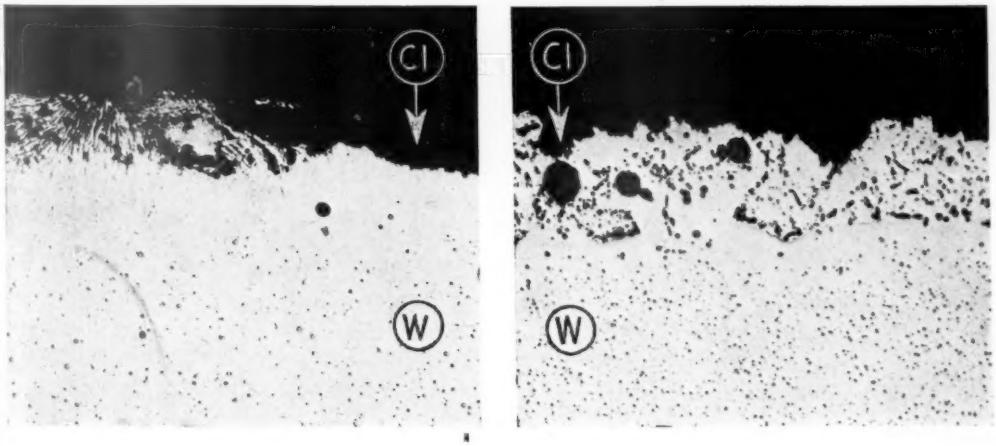
Impact properties.—The results of unnotched Charpy impact tests made at room-temperature are given in Table V. The axis of the weld was at right-angles to that of the impact test-piece, and the hammer was directed at the root of the weld. The line of impact passed through a point in the weld metal 1 mm. distant from the weld junction at the weld face, as illustrated in Fig. 5*a*. Under these conditions of testing, the path of fracture in most of the test-pieces was along the line of impact.

The impact strength of the as-welded joint in the pearlitic plate was similar to that of the parent material, and was unaffected by heat-treatment at 550 deg. C. for 2 hrs. The full-ferritizing treatment trebled the impact strength of the as-welded joint in the pearlitic material.

The impact strength of the welded joint in the ferritic material was about one-sixth that of the parent plate. Treatments at 600 deg. C., 700 deg. C., and the full-ferritizing treatment increased the impact strength of the joint but the impact values obtained were about one-third those obtained for the unwelded ferritic material. These results also show that the impact properties obtained as the result of ferritizing welded joints in pearlitic and ferritic materials were similar.

A second type of impact test-piece, illustrated in Fig. 5*b*, was machined from welded joints in ½-in. pearlitic plate. In these joints one plate of each pair had a square edge, abutting the bevelled edge of the second plate machined at an angle of 45 deg. The vertical limb of the weld was positioned parallel to the line of impact, which passed through the plate material at a distance of 1 or 2 mm. from the weld junction. Under these conditions of testing, failure appeared to occur at the weld junction of the pearlitic plate, both in the as-welded joint and in those

FIG. 6 (*a*) AND (*b*).—*Path of fracture in impact test-pieces from welded pearlitic iron plate: (a) (left) as-welded (b) fully ferritized.* (× 125; *C.I = cast iron; W = weld metal.*)



Welding of Spheroidal-graphite Cast Iron

treated at 550 deg. C. for 2 hrs. The impact strengths were between 3½ and 7 ft. lb., *i.e.*, about half the values obtained with the other test-pieces. Microscopical examination showed the path of fracture to be partly through the narrow zone of cementite which, as described later, formed at the weld junction during welding, and partly through the adjoining nickel/iron weld metal. This feature is illustrated in Fig. 6*a*. Similar impact tests were made on the welded joint after a full-ferritizing treatment. Fracture in these test-pieces occurred in the cast iron close to the weld metal, as in Fig. 6*b*. The impact value obtained when the test-piece was struck 1 mm. from the weld junction was 28 ft. lb., which approaches the values obtained previously on a heat-treated vee-joint.

FIG. 7 (*a*) AND (*b*).—*Hardness surveys across welded joints in pearlitic and ferritic iron plates: (a) using Ni/Fe electrode, and (b) using Al-bronze electrode.*

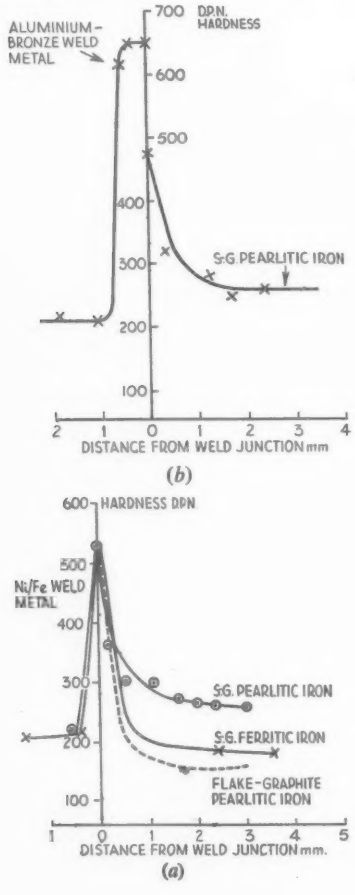


TABLE V.—*Unnotched Charpy-impact Properties of Welded Joints in S.-g. Cast-iron Plates ½-in. thick. (Nickel/Iron Electrode.)*

Initial plate structure.	Condition of plate.	Impact strength at 25 deg. C., ft.-lb.
Pearlitic ...	Unwelded	11 10 11
	As-welded	13 13
	Welded plus 2 hr./550 deg. C. ...	11
	Welded plus 3 hr./900 deg. C. plus 16 hr./700 deg. C.	36 40
Ferritic ...	Unwelded	101 101
	As-welded	14 20
	Welded plus 2 hr./600 deg. C. ...	34 31 33
	Welded plus 8 hr./700 deg. C. ...	36
	Welded plus 2 hr./850 deg. C. plus 8 hr./700 deg. C.	36 33

Hardness.—Hardness determinations were made in the heat-affected zone and in the weld metal of the joints in the 1-in. thick pearlitic and ferritic plates. The results of hardness surveys across the joints in the as-welded plates are presented in Fig. 7*a*. The full lines depict the hardness gradients obtained in the s.-g. cast-iron plates, and for comparison the hardness gradient obtained in a welded joint in flake-graphite pearlitic iron is indicated by the broken line. These surveys show that the maximum hardness (about 520 D.P.N.) occurred at the weld junction. These, and the other hardness surveys described later, were made at the position midway between the top and bottom surfaces of the joints.

The hardness of the heat-affected zone decreased rapidly as the distance from the weld junction increased, and the normal hardness value of the plate was obtained in the three irons within a distance of about 2.5 mm. from the weld junction.

There was, however, considerable scatter in the hardness values obtained along the weld junction: the ranges of hardness obtained at this position in the as-welded and heat-treated plates are given in Table VI, together with the average hardness values at the weld junction and in the weld metal. Treatment at 550 deg. C. and at 600 deg. C for 2 hrs. did not markedly lower the hardness at the weld junction or in the weld root, but the heating at 700 deg. C. for 8 hrs. and the full-ferritizing treatment reduced the hardness of the heat-affected zones to that of unwelded ferritic plate, and also softened the weld metal in the root runs.

Microscopical Examination

The microstructures of the welded joints in the pearlitic and ferritic 1-in. thick plates, in the as-welded condition, are compared in Figs. 8 and 9. Pools of eutectic and austenite dendrites occurred at the weld junction and in the adjacent heat-affected

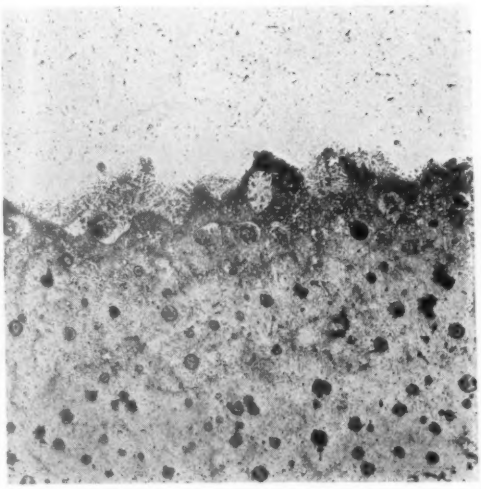


FIG. 8.—*Weld junction in pearlitic s.-g. iron plate.* (× 40.)

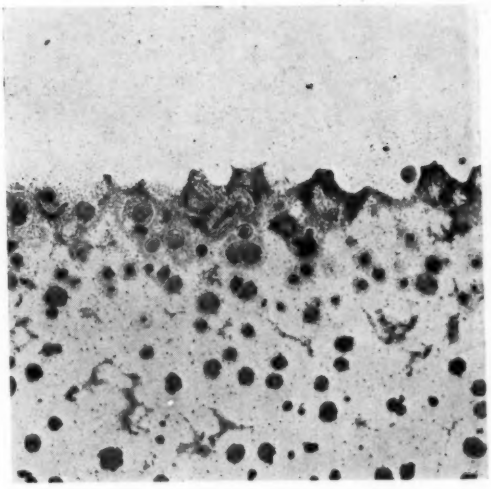
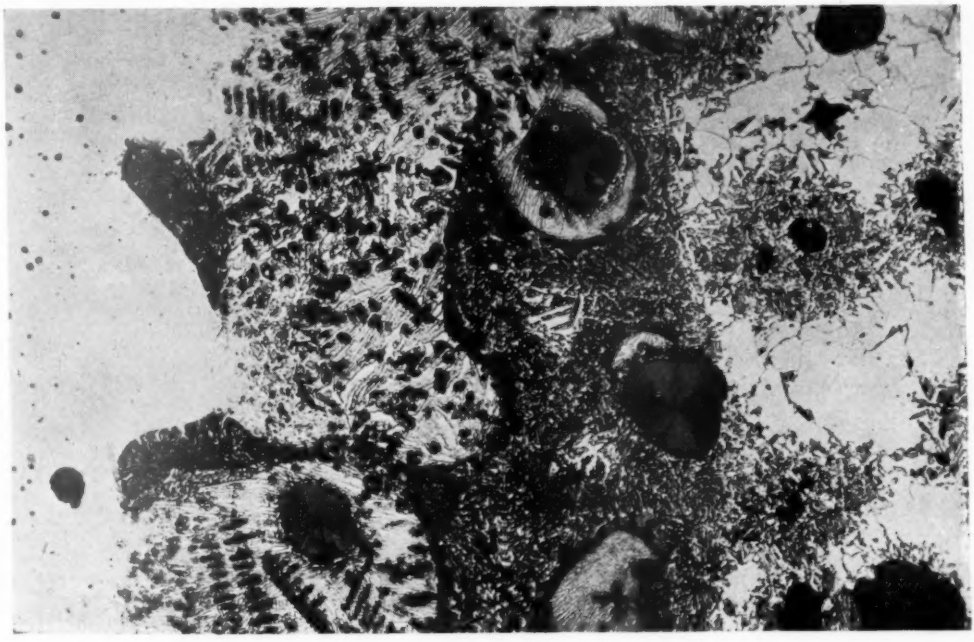


FIG. 9.—*Weld junction in ferritic s.-g. iron plate.* (× 40.)

zone. The structural changes in the ferritic plate occurred primarily in the vicinity of the graphite spheroids (Fig. 9), but in the pearlitic plate the matrix in the heat-affected zone also transformed mainly to harder products. The widths of the heat-affected zones in the pearlitic and ferritic plates were estimated to be about 2 mm. and 0.8 mm. respectively.

The details of the structural changes in welded ferritic plate are presented at higher magnification

FIG. 10.—*Microstructure at the weld junction in ferritic iron plate as welded.* (× 300.)



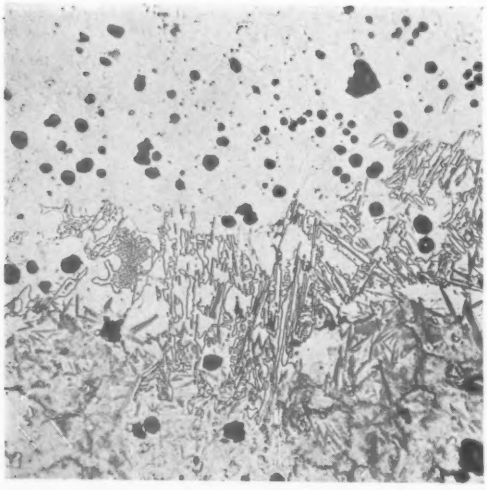


FIG. 11.—*Cementite at the weld junction in ferritic iron plate.* (× 300.)

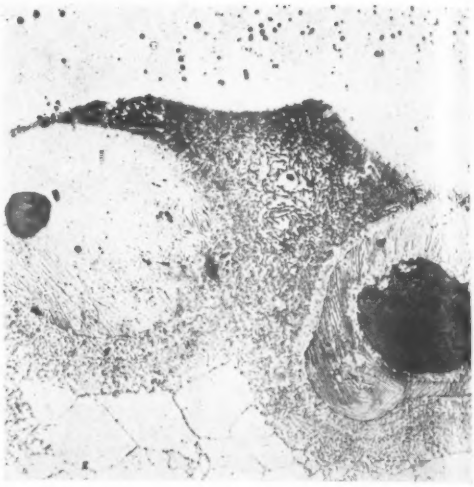


FIG. 13.—*Weld junction in welded ferritic iron plate heat-treated for* 2 *hr. at* 600 *deg. C.* (× 300.)

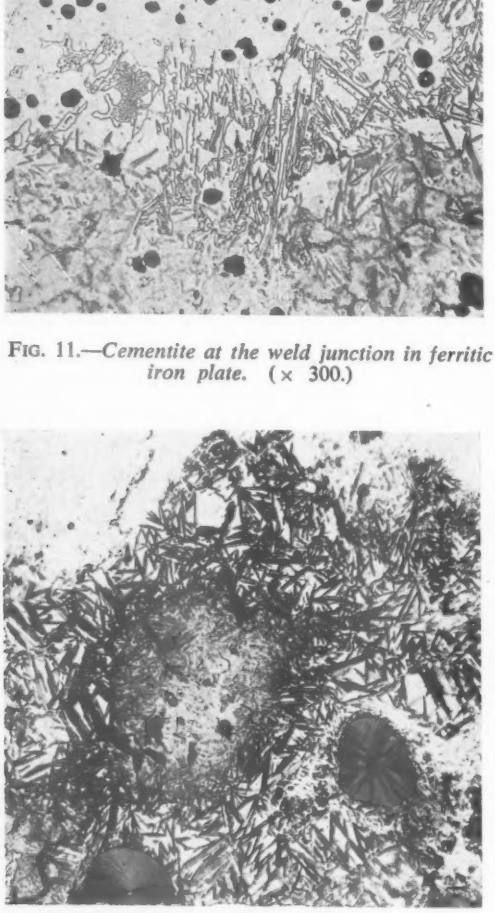


FIG. 12.—*Lightly-tempered martensite at the weld surface of ferritic iron plate, as welded* (× 300.)

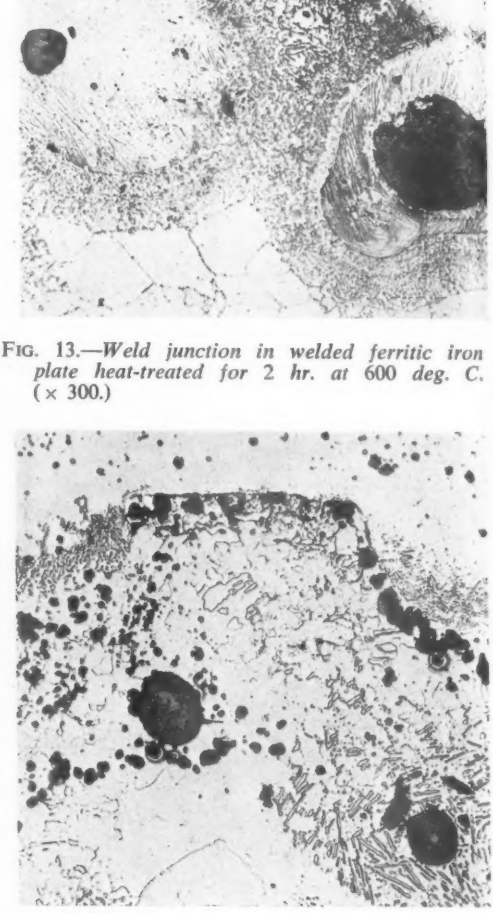


FIG. 14.—*As Fig.* 13, *but heat-treated for* 8 *hr. at* 700 *deg. C.* (× 300.)

in Fig. 10. The pool-like zones were composed mainly of fine eutectiferous cementite plates, and the maximum hardness of the heat-affected zone was found in this aggregate. The cementite plates often extended into the weld metal (Fig. 11). Martensite and bainite structures were formed at and close to the weld junction. Except at the surface of the completed weld these transformation products had been noticeably tempered by the welding heat of each successive weld run. At the weld surface, the martensite was only lightly tempered, as in Fig. 12, and together with the eutectic formed a substantial zone of high hardness (up to 600 D.P.N.). At positions remote from the weld junction in the heat-affected zone, ferrite/carbide aggregates were formed and these showed relatively low hardness values. It is probable that the larger volume of martensite which formed in the pearlitic plate during cooling after welding set up excessive stresses in the heat-affected zone and led to cracking there, as illustrated pre-

TABLE VI.—*Hardness Determinations on Welded Joints of Pearlitic and Ferritic Plates of S.-g. Cast Iron 1-in. Thick (Nickel/Iron Electrode).*

Initial plate structure	Condition of plate.	Hardness, D.P.N.				
		Weld junction.		Weld metal.		Plate.
		Range.	Average.	Root.	Centre.	
Pearlitic ...	As-welded	350/535	435	225	190	265
	Welded + 2 hr./550 deg. C.	350/555	445	205	175	275
	Welded + 3 hr./900 deg. C. + 16 hr./700 deg. C.	160/185	170	180	180	165
Ferritic ...	As-welded	243/510	350	251	205	190
	Welded + 2 hr./600 deg. C.	290/420	360	235	185	170
	Welded + 8 hr./700 deg. C.	170/180	175	205	195	170
	Welded + 2 hr./850 deg. C. + 8 hr./700 deg. C.	165/175	170	175	180	165

viously in Fig. 2. The effect of pre-heating to 200 deg. C. was to retard the progress of the martensite transformation and so allow transformation stresses to be dissipated gradually in adjacent material. This precaution was not required in the welding of the ferritic plates, as a high proportion of ductile ferrite remained quite close to the weld junction (Fig. 10).

The effects of heat-treatment on the microstructure at the weld junctions of the joints in the pearlitic and ferritic plates, are illustrated in Figs. 13 to 15. The treatments at 550 deg. C. and 600 deg. C. for 2 hrs., only tempered the martensite and bainite transformation products in the pearlitic and ferritic plates, and no marked structural change occurred (Fig. 13). A considerable amount of graphitization had occurred in the ferritic plate heat-treated for 8 hrs. at 700 deg. C. (Fig. 14), and resulted in the formation, in the vicinity of the weld junction, of new spheroids of graphite which were much smaller than those in the original plate. Some of the eutectiferous cementite remained. After the full heat-treatment, the structure of the welded joints in the pearlitic and ferritic plates were similar and, as depicted in Fig. 15, were characterized by the presence of small graphite spheroids which had replaced completely the carbide structure at the weld junction. The nickel/iron weld metal also contained a large quantity of fine s.-g. particles, as illustrated in Fig. 16.

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[5] Inst. Brit. Foundrymen, "Code of Practice for the Repair and Reclamation of Grey-iron Castings by Welding and Allied Methods," *Proc.* Inst. Brit. Foundrymen, 1950, **43**, A115-A122. (Report of Sub-committee T.S.23 of the Technical Council.)

[6] Everest, A. B., Ball, F. A., "Repair of Grey-iron Castings in Great Britain," International Foundry Congress, Paper CI-2, 1953;

(To be continued)

FIG. 15.—*Weld junction in welded ferritic iron plate fully ferritized.* (× 300.)

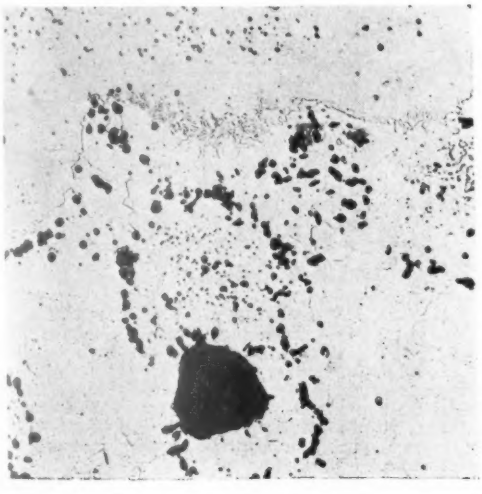
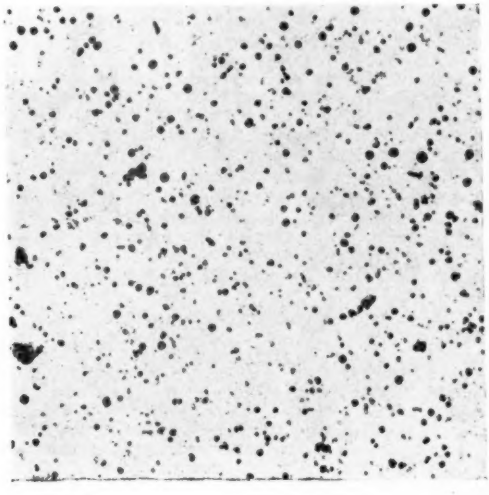


FIG. 16.—*Structure of nickel/iron weld metal. unetched.* (× 300.)



Publications Received

"Ironmonger" Pocket Book of Tables (Eighth Edition). Published by the "Ironmonger," 28, Essex Street, Strand, London, W.C. 2. Price, 3s. 6d. net.

There are about 100 tables carried on 56 pages. Since the last edition they have been expanded and new ones covered. Quite a number relate to products, whilst others are useful for calculations.

Brief Subject and Author Index of Papers in the Proceedings, 1937-1953. Published by The Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, S.W.1.

The reviewer remembers, when dealing with an earlier issue of the index of Papers given before the Institution of Mechanical Engineers, noting the long gap stretching from the 1880's to the 1920's, during which foundry practice was apparently ignored. This issue points to ten important papers appearing in the Proceedings during a much-reduced period. It is a very useful publication and one which should be kept for reference.

Progress Report, 1953—1954.—Published by the British Productivity Council, 21, Tothill Street, London, S.W.1.

The main report is set out, peculiarly enough, under the heading "Introduction." What follows is an analysis of the extension and work of the local production committees of which there are now no fewer than 94. The reviewer believes that the time has now arrived for the work to infiltrate into the shops *via* these local committees, allowing international activities to fade out gradually. The report includes a list of films available for propaganda purposes. It is a publication that should be read by everybody.

Gateway to Opportunity. Issued by Glenfield and Kennedy Limited, Kilmarnock.

This booklet surveys, for the benefit of parents and youths, the opportunities the firm offers to those who enter their employ as apprentices. The cover is particularly well done as it illustrates the attractive main gates of the works. Something of the history of the firm is given, more of its engineering accomplishments, but the main subject of the various types of training offered occupies the bulk of the space. Stress is rightly laid upon study—both external and internal—if the boy is to take the best advantages of the important opportunities afforded. These are so good, that it is difficult to envisage that there will be a shortage of recruits in the foreseeable future.

Corrosion Problems and Prevention in the Chemical and Petro-Chemical Industries in the U.S.A. Published by the Organization for European Economic Co-operation and available from Her Majesty's Stationery Office, P.O. Box 569, London, S.E.1, price 8s. 6d.

This report was made by a group of European technologists after a visit to plants, universities and research stations in the United States. It scarcely enters into matters concerning the foundry industry, but it does give an appreciation of the size of the problem and refers to its amelioration at the design stage. By focusing attention on this aspect, there may result indications that more-expensive materials used initially may ultimately save money.

New Equipment

Bench-type Coreblower

Constructional Engineering Company, Limited, Titan Works, Birmingham 12, have given the name "Titanette" to the bench-type coreblower shown in Fig. 1. No doubt inference is intended that it is a small machine in relation to their "Titan" models, yet this is a little misleading, for both Titanette models, mark I and mark II will make sizeable production cores. Indeed, the hopper capacity of the mark II, at 36 lb., and the corebox accommodation—up to 8¼-in. high, by 14½-in. deep, by 24-in. wide—bring it into the medium-to-large coreblower range. Similar figures for the mark I are 12 lb. and 7½ by 12 by 20 in. Special features claimed for the models include: No special foundations required; only two moving parts; simple, robust construction; blowing plate of large area and easily changed; simple, yet accommodating clamp operation, both horizontally and vertically.

Neither model is a cartridge blower, so that interruptions to blowing are only necessary for re-charging the hopper—the frequency depending on the weight of core being blown. A non-mechanical system of sand aeration is incorporated in these new models as distinct from Titan machines, and this, it is claimed, lowers the price range considerably. This aerating feature makes for sound core production at quite-low blowing pressures; indeed, it is stated that shell cores, for which the machine is eminently suited, can be blown at pressures as as low as 10-lb. per sq. in.

At a demonstration of these machines, attended by the writer, cores of fair size and considerable intricacy, both in shell core-sand and ordinary mixes, were blown with ease and speed.

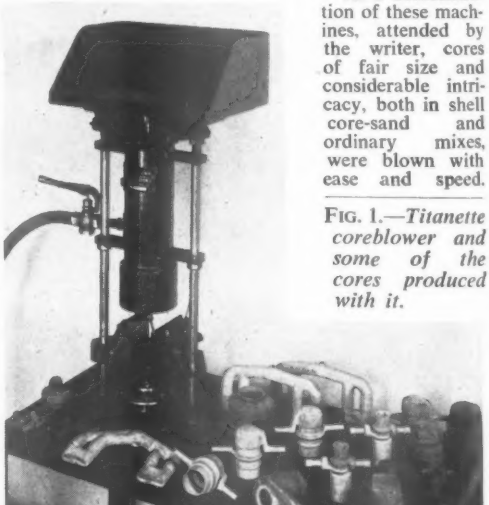


FIG. 1.—*Titanette coreblower and some of the cores produced with it.*

THE MAIN FEATURE of the Wellworthy exhibits at the 1954 Cycle and Motor-cycle Show will again be the Al-Fin cylinder barrels. A large range will be shown, suitable for most types of motor-cycle. Al-Fin barrels are said to be up to 50 per cent. lighter in weight than cast-iron barrels. It is claimed they dissipate heat much more quickly and permit much higher engine performance.

Die-pressing of Gutters*

Discussion of the Paper by R. S. M. Jeffrey and J. A. Richards

The die-pressing method of cast-iron rainwater-gutter manufacture is one of the most outstanding inventions of post-war foundry practice and its full description was one of the technical "highlights" of the Glasgow conference of the Institute of British Foundrymen. In the discussion following presentation of the Paper, which is reported here, information was requested on kindred processes developed on the Continent; the metallographic structure of the castings produced; effect of composition; modus operandi; *machinability of the castings; a cupola control device and the effects of contraction.*

MR. F. C. EVANS first congratulated the Authors on the method they had developed for producing the gutters; it was most ingenious and he was sure its development had called for an immense amount of perseverance. Most foundrymen, if asked whether gutters could be produced by that process, would have been quite certain that it was not possible. He asked what was the rate of production of the machine and the number of people employed in operating it, for those factors obviously had a big influence on the economics of the process.

Continental Processes

On reading the description of the process he had noted that the main reason why it was developed was to eliminate annealing. The heart of the matter was that the gutter was withdrawn from the die before it reached the hard state. But he was wondering whether annealing did cost so much as was implied, and he invited the Authors to comment on the relative economics of their process and the Continental machine which he had seen recently which was capable of producing gutters by a centrifugal method; two gutters, 6-ft. long, were produced at a time, at a rate which could reach 35 to 36 pairs per hour, or 60 to 70 gutters per hour. It was true that the gutters produced by the latter machine had to be annealed, which involved extra cost; but he wondered whether, if the metal composition were different and if methods were used such as those developed in Sweden for soil pipes, annealing would then be necessary.

MR. RICHARDS said it was stated in the Paper that a casting was made in 90 secs. and that cooling arrangements had to be made to meet that rate of production. There were three men in a team working the machine.

MR. JEFFREY, dealing with the suggestion that the gutters were removed from the machine before they reached the hard condition, drew Mr. Evans' attention to references 2 and 3 at the end of the Paper, namely the papers by Morrogh and Williams and by Eash on the subject of graphitization. One might find those papers a little formidable, but they provided a very complete explanation of the structure obtained. In the present Paper, there was no attempt to explain why grey-cast-iron structures should be obtained, but the two earlier papers mentioned gave explanations which apparently fitted the case. The point was not that the gutter was withdrawn before it reached the hard condition. The explanation was that the gutters solidified with a "white" structure, but they then graphitized. The under-cooled graphite structure which was illustrated was typical of die-cast material subsequently graphitized.

He was interested in the process used on the Continent which was producing 60 to 70 gutters per hour, though he was not familiar with it. The process described in the Paper produced a gutter in approximately 90 secs. However, he drew attention to Mr. Evans' statement that the gutters produced by the Continental process required annealing. He was familiar with the Swedish process for producing soil pipes, where a hot mould was used and the castings were removed from it very speedily. The castings produced were grey, and did not require annealing. He asked if Mr. Evans could give him any further reference to the Continental process for producing gutters.

MR. EVANS said the machine used was the Rothfischer machine.

Metallurgical Aspects

MR. H. P. HUGHES was interested particularly in the metallurgical aspects of the process described, and asked if the Authors could say what tolerance there was with regard to weight and dimensions. He appreciated that that was of little consequence in relation to a gutter, but in the application of the process to the production of other castings, it might be a very important factor.

One metal composition was given in the Paper as being suitable for the production of gutters, but no doubt the Authors would have tried many and varied compositions. He asked for some idea of the sort of results obtained with different types of cast iron, mainly from the composition point of view, with extreme carbon figures, low and high, coupled with extreme silicon figures.

Next, he asked how the Authors determined the range of temperature, which was very short, or how they limited the temperature range to ensure that they obtained the conditions required. In the circular section, the temperature variation must be considerable as the result of the rapid cooling.

The explanation of the process served to show how difficult it was to understand the theories that were associated with the cooling of cast iron. Cast iron was cooled in a sand mould to get a grey soft iron, it was cooled somewhat faster in a metal mould to get a chilled iron, and when cooled

* Paper printed in the JOURNAL, October 21, 1954.

faster still by the method explained in the Paper a grey structure was obtained.

MR. RICHARDS said that weight was a very vital factor in the light castings trade and it had to be controlled fairly closely. A gutter would weigh about 15 lb., and one weighing 16 lb. was undesirable. With regard to dimensions, if a whole 6-ft. length of gutter were sectioned longitudinally, the maximum variation in thickness would not be more than $\frac{1}{8}$ in.

Effect of Compositional Variations

MR. JEFFREY, discussing composition variations, said it would be appreciated that one of the reasons for controlling composition was to control slag. If they used a higher silicon content, more surface slag was formed. A certain amount of silicon was needed to give the correct structure in the casting, but if there was an excess of silicon there would be trouble with slag formation on the metal surface.

It was necessary also to control fluidity very closely, and in order to do that it was necessary likewise to control primarily the carbon. Mr. Evans in an earlier Paper had given some very interesting figures relating to the influence of carbon on fluidity, and it was a very marked feature of the process for producing gutters that the carbon must be kept very closely under control, for otherwise the timing of the machine was upset. He would not say that if the composition varied, one could not vary the timing to suit; but immediately one began to alter one factor, bearing in mind the complexity of the process, there was the problem of rebalancing all the variables.

If stripping were done too quickly phosphide extrusions appeared. These gave a fairly definite indication of the correct stripping temperature, which was at just under the solidification temperature of the phosphide eutectic. If the die were opened earlier than that, there was phosphide extrusion, the phosphide being pushed out as the expansion took place on graphitization.

It seemed that there was a little confusion of thought among members as between the solid, closed die and that used on the machine for producing gutters. In the gutter process solidification took place in the closed die, but cooling did not.

Possible Application

MR. J. BLAKISTON asked whether experiments had been made with different inoculating media, added at the cupola spout or in the cupola direct, using such materials as calcium silicide or ferro-silicon, or the utilization in the cupola direct of calcium carbide to bring about graphitization to produce a grey fracture.

A question of particular interest was whether in the opinion of the Authors the process described would be adaptable to the production of rice bowls, which were hemispherical castings from $\frac{3}{32}$ in. to $\frac{1}{4}$ in. thick. Rice bowls represented one of the major world consumptions of light castings, and many mechanized plants had been put down in the attempt to manufacture them, but he believed that in most cases they had all proved a financial failure. In that field, the foundry industry had to compete against "cottage" industries, which produced rice bowls at anything from 7d. to 1s. 3d. each, and each casting incorporated a couple of wire handles. It occurred to Mr. Blakiston that the process the Authors described might provide a solution to the problem, and he asked for their opinion as to whether the process could be adapted for operation by a multi-head machine or in some other manner.

MR. RICHARDS replied that he was once connected with the rice-bowl business. The difficult job was to incorporate the wire handles, but if the bowls could be made without handles the job would not be too difficult and the die-pressing process might be suitable. However, he could not see an easy way around the wire-handle problem. The Authors were developing another type of machine which would be useful for that particular class of work, their purpose being to produce a far more difficult casting than the rice bowl, namely, the rainwater head. There was no doubt that the pressing process would be excellent for producing rice bowls, if the wire-handle problem could be overcome and the process could be made competitive.

MR. JEFFREY, replying to the question on inoculation, said the Authors had carried out quite a few experiments, using various inoculants, but their final conclusion was that they could obtain the required metallurgical structure without inoculation.

MR. D. MCK. WEBSTER asked whether the castings produced by the process described would enamel well.

MR. JEFFREY replied that using the wet process, castings produced by die-pressing enamelled very well indeed. Dry-process enamelling had not been tried.

Mechanical Details

MR. R. KENNEDY commented on the mechanical side of the machine and asked for how long the 4-h.p. motors used remained in the stalled condition.

MR. JEFFREY replied that the motors were in the stalled condition for anything up to 10 sec.

MR. KENNEDY said that, apparently, stalling occurred once in approximately 90 sec. If the metallurgical considerations permitted a speeding up of the process, he asked, what would be the maximum number of times per minute that motors of that kind could be stalled?

MR. RICHARDS replied that the load was controlled to a maximum of 100 per cent., and the motors could be stalled indefinitely. He did not mean that there was 100 per cent. overload; the current never exceeded the maximum rated current, and the motors were not overloaded when they were stalled.

MR. KENNEDY said he believed the top or male die weighed about 4½ cwt., and asked what was the accelerating and decelerating time when the die came over the cam.

MR. RICHARDS replied that it took approximately 1 sec. to drop from the open position to the point about 1 in. above the cam, where it paused and then re-started.

MR. KENNEDY said it seemed to him that half the time was taken in accelerating and half in decelerating it.

MR. RICHARDS agreed that was the case.

Machinability

MR. H. P. HUGHES, after commenting that rainwater castings did not need machining, asked whether the process would be applicable to the production of castings where extensive machining was necessary, and whether work had been carried out on the machinability of the material in the form of castings, prior to annealing.

MR. JEFFREY said the question was difficult for him to answer. No doubt it had been noted that the Brinell hardness quoted was quite reasonable for conferring machinability, but he was not prepared to comment as to whether the type of undercooled graphite structure exhibited would be an advantage or a disadvantage from that point of view.

MR. HUGHES said he imagined it would be a disadvantage.

MR. JEFFREY added that, considering the strength of the castings produced, they were remarkably soft and saw cutting could be carried out quite readily.

MR. H. MORROGH said it was difficult to generalize about machinability, but it was possibly true that the graphite structure was of less importance than the matrix structure. In the Authors' samples the matrix had a considerable amount of ferrite, as was shown by the published micrographs, so that it did conform very closely to iron having maximum machinability.

MR. JEFFREY added that the process had not so far been applied to the production of castings which had to be machined apart from cutting so that he could not give experience of machining. He drew attention, however, to a number of saw cut specimens on display.

Cupola Charging Control

MR. W. J. DRISCOLL, recalling Mr. Jeffrey's reference to an indicator light which told the cupola charging crew when the cupola was ready for another charge, asked if he could give more details of the method of operation and could say whether the device was completely reliable.

MR. JEFFREY said the method had been devised at the foundry. It consisted of iron blocks or bricks which were built into the cupola wall; there were two rows, and in each row there were four pairs, that is, eight bricks per row. If any two of the eight bricks in either of the two rows were shorted across by the metallic charge, a red light showed. The device was found to be invaluable used in conjunction with the drop-bottom bucket used.

MR. DRISCOLL asked what was the voltage across the blocks or bricks.

MR. JEFFREY said it was 24 v. d.c. and added that he would be very happy to give Mr. Driscoll further particulars.

MR. RICHARDS said that when the automatic charger was in use, the indicating-light electrical system would be interlocked with the charger control panel, so that charging could not take place unless the cupola was clear to take the charge.

Team-work

MR. F. W. BATES, dealing with the point that there were three operators on the machine, said he assumed they were working actually on the die-casting machine; or did they operate also on the clamping device afterwards, so that the whole unit would have only three men? He supposed that there were pourers in addition.

MR. RICHARDS said there were only three men, including the pourer.

MR. BATES commented that for three men to be able to run the whole unit was very commendable. With regard to the indicator lights which indicated to the operators when to pour, he asked whether the giving of the indication was determined by the dies themselves, and what were the temperature variations along the length of dies. Further, he asked for a little more information on the tensioning device in the dies, to overcome expansion. Finally, he asked what process was used for cutting the gutters. He had heard of gutters splitting along the length rather than cutting across the width.

MR. RICHARDS said there were three men in a team. One of them received the metal and poured it, and the other two handled the casting from the die to the clamping device; one of those two removed the flash in the clamping device and the other one re-coated the mould. There was no great variation in the temperature of the dies throughout its length; controlled air-cooling was used to maintain a fairly even temperature.

The indicating lights were not controlled by thermocouple, but entirely by time. There was a pilot motor in the control panel which was pre-set to operate relays at certain time-intervals to work the indicating lights.

The cutting was done with a hacksaw but a further advance had been made; it had been found that if the top of the half-round gutter were cut for about $\frac{1}{2}$ in. deep—which was about the depth of an ordinary hacksaw blade—and the gutter was knocked on the edge of a brick, a clean break was obtained at that point.

Contraction

MR. BATES said that, obviously, when the gutter cooled it contracted, and asked if the Authors found that it contracted on to the male portion of the die and lifted away. Again, if it remained in the female die, was it in actual physical contact with that die or did it lift and come partly out of the die, giving the advantage of a layer of air between the die and the casting, which would help to insulate the casting to obtain the grey structure of the metal.

MR. RICHARDS said the casting always remained in the female die. That it did *not* move was one of the features which was of such advantage in the process. Provided the timing was correct, the casting remained in the female die. As to the cooling, once again, provided the male die was removed, it did

Die-pressing of Gutters—Discussion

not matter how long the casting remained in the female die; the casting was still soft.

Appreciation

THE CHAIRMAN, Mr. H. J. V. Williams (junior vice-president), in thanking the Authors for their Paper, said that, as one who had no connection with this branch of the foundry industry, he had very much enjoyed listening to the Paper for it was very revolutionary. That the Paper had been presented to a conference at Glasgow, so near to the heart of the light iron castings industry, was very appropriate.

MR. JEFFREY, repeating the Author's thanks to the directors of Federated Foundries, Limited, and to the British Cast Iron Research Association, particularly to Mr. Morrogh and Mr. Sumner, for assistance on the technical aspects, said they were very appreciative. Obviously, he said, heat transfer into the die, and die cooling, had been great problems. His firm had recently applied for a further Patent to cover differential cooling and cooling by means other than air. Both the machine and the process described in the Paper were covered by Patents, but it had been thought necessary to introduce differential cooling, particularly in the handling of castings of differing sections.

New Technical College for West Bromwich

Sir Frederick Handley Page opened on October 15 the new £330,000 Technical College at West Bromwich. Sir Frederick said that in the immediate environment of West Bromwich there were many well-known iron and steel works, and he imagined that at that college they would be concerned with the problem of training the young entrants to the iron and steel industry.

On technical education generally, Sir Frederick said that it is only since the war that we have, as a country, become alive to its immense importance, but he was convinced that, despite the great strides which have been taken in the last seven or eight years in the provision of technical education, we still have much to do both in the amount of provision and in clearer thinking about the kind of provision.

On technical college staffing, Sir Frederick said: "Nothing can be more profound in its influence than the teaching of a craft by a master craftsman of integrity. It is in the content of the teaching that we see most clearly the results of the very real partnership in technical education which exists between industry on the one hand and the educationist on the other." He added that he would like to see an extension of the possibilities of technical college lecturers returning for periods in industry and of those employed in industry enjoying spells in technical colleges.

The eight-storey block of the new college incorporates facilities for all branches of technical training and includes a metallurgical laboratory equipped with the most modern furnaces; laboratories for heat-treatment; a large drawing office; a welding laboratory; special classrooms for foundrywork, engineering, advanced mechanics, metrology and machine-tool work, etc.

Sankey's Centenary

Joseph Sankey & Sons, Limited, who are celebrating their centenary this year, have no records to show on what day or in which month this now nationally famous concern was founded. It was started in 1854 in a one-room workshop by the man after whom the company was named. Joseph Sankey, born in 1826, had been a japanner but decided, with two friends, Hartill and Jackson, to open up a factory in Dudley Street, Bilston. From making tea-trays, Sankey began manufacturing holloware and by 1874, when Joseph Sankey's son joined the firm, it had 65 workpeople and had outgrown the original premises. In 1887, the electrical lamination side of the business began and a new factory was opened in 1900 at Bankfield. The Bankfield works to-day are the largest in Europe for the production of laminations for the electrical and allied industries.

In 1902, the business was converted into a private limited company with John William Sankey as chairman. In 1904, Manor works near Wolverhampton was acquired to make the electrical steel sheets for Bankfield, and in 1909 the first steel body-panels were made for the Arrol-Johnson car, and the Sankey connection with the motor industry began. At about the same time, Sankeys developed the first pressed-steel artillery wheel that was to replace the wooden wheel previously used. Hadley Castle works, at Wellington, were added in 1910—a factory which produces pressings for the shipbuilding, aircraft and building industries as well as wheels for private and commercial vehicles.

In 1919 John Lysaght, Limited, obtained a controlling interest in the company and shortly afterwards Guest Keen & Nettlefolds, Limited, and thus Sankeys entered the G.K.N. group. The Bilston works were bought in 1929 and to-day components for jet aircraft engine and pressings of all kinds are made, including ladle bowls for the foundry industry. In 1943, Sankeys began the production of electrical laminations in Bombay, and seven years later another factory was opened at Calcutta and a third in Newcastle, Australia. In 1950, a factory in Johannesburg was started and in 1952 a Canadian works opened. In Britain, Sankeys extended to Hereford, Dudley and Stourport. At the end of its century of growth, Sankeys employs 9,000 operators. Throughout the entire 100 years, sons and grandsons of the founder have directed the business.

Birlec Overseas Order

An order valued at approximately £115,000 for electric melting furnaces has recently been placed with Birlec, Limited, Tyburn Road, Birmingham, by Tata Locomotive & Engineering Company, Limited, India. The order, which was obtained in the face of global competition, calls for two 4-ton and two 7-ton capacity Birlec Lectromelt electric-arc furnaces to produce high-grade iron and steel for use in the new Tata foundries at Jamshedpur. The geographical location of these works presents special difficulties, as they are situated in a region where ambient temperatures as high as 120 deg. F. and humidities approaching 100 per cent. sometimes occur. Delivery of the furnaces and the ancillary electrical gear is to be made during the summer of 1955, erection being carried out by local labour with the advice and guidance of Birlec technicians and with the co-operation of the company's India agents—Thos. W. Ward (India), Limited.

Induction-hardened Slideways on Cast-iron Lathe Beds*

By W. Malmberg

The slideways and bearings of a machine-tool determine to a far-reaching extent the accuracy obtained in operation by the action of the tool on the component. The problem is relatively simple to solve when the machine is new and appreciable wear has not occurred. Wear occurring after prolonged operation introduces serious problems. This is fairly easy to combat in the case of the machine bearings, but greater difficulties are encountered in the case of operational wear occurring with the bed slideways. The problem is most difficult with centre-lathes as the requirement of good lubrication and cleanliness so as to avoid wear are not easy to achieve. It is believed that increasing the hardness of the lathe bed presents a satisfactory solution to this problem. Before the war, the Brinell hardness of a good lathe-bed slideway was of the order of 170 to 180. To-day, normal values are between 210 to 220. A further increase has been obtained by the use of chilled castings; here, a limitation is set by machining difficulties.

The trend of development has been the direct hardening of the bed guides. Initially, this was done by autogenous surfacing; since December, 1948, induction hardening has been introduced. The German firms of Heidenreich and Harbeck, of Hamburg, and the Lehrenfabrik Rissen G mb H concern carried out experiments and the results have led to many thousands of lathe-bed guides being hardened. This process is as simple and certain to apply as an ordinary machine tool operation.

Fundamental Principles

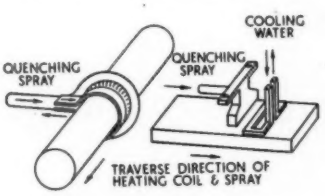
The theory of induction hardening is now well known. The heating effect is obtained by means of eddy currents induced in the skin of the metal by a high-frequency current passing through the heating coil in which the member is inserted. The penetrative effect of the heating is dependent upon the frequency; the higher the frequency the more the heating effect is concentrated on the surface of the metal. Directly after the heating, which is very rapidly carried out, the metal is quenched by means of a spray of cold water. The arrangement for the process is shown in Fig. 1. Here it will be seen that after the material has been heated, it is subsequently directly quenched. This signifies the end of the hardening process. With small parts, the heating is done in a stationary manner; with large components the area of heating and quenching is traversed along the material by a relative movement between the component and heating coil, together with the quenching arrangement. It is only since this progressive motion was introduced that it has become possible to harden large surface-areas with the use of commercially low electrical power outputs.

Because of their great length, centre-lathe guides can only be hardened in this way. The positioning of the heating coil and the part being hardened must be maintained constant for the duration of the heating and a uniform relative motion between these two must be produced. The heating coil and the component form an air transformer in which the former represents the secondary coil. The air gap has a width of 0.5 to 1.0 mm. and this must be maintained with an accuracy of ± 0.025 mm. when high-frequency energy is used. The maintenance of this tolerance presents one of the greatest practical difficulties of lathe-bed hardening. If the spacing distance of the heating coil exceeds the limit quoted, there results a smaller energy transfer and a smaller hardening depth. This however is less harmful than the reverse condition in which the heating coil approaches too closely to the component. In such an event, the energy transfer is increased and even in a fraction of a second such high temperatures are produced that the melting point limit can be exceeded. The spacing tolerance mentioned of ± 0.025 mm. is based on a frequency of 250 kilo-cycles and narrow coupling. With medium frequencies of 10 kilo-cycles the relations are more favourable. The air gap can be greater and with this the tolerance field is likewise greater. As long as relative motion is arranged, the bed can be either the static or the mobile part. Both arrangements have advantages and disadvantages.

Metallurgical Requirements of the Cast Iron

Centre-lathe beds are usually constructed of grey cast iron. Requirements for the induction "hardenability" are the presence of at least 0.5 per cent. of carbon in the combined form. As compared with steel, grey cast iron possesses two appreciable structural constituents which are absent in steel: graphite and phosphide eutectics. At high temperatures, the graphite passes into solution and the more rapidly, the higher the temperature. With induction hardening, however, the temperature and the time

FIG. 1.—*Schematic diagrams of two suitable arrangements for induction hardening; left, for a cylindrical component and, right, for a surface.*



* Extracted from *Werkstattstechnik und Maschinenbau*, 44, No. 3, pp. 104-108 (March, 1954).

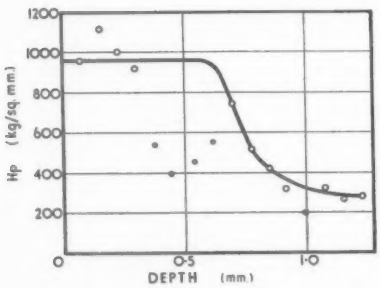


FIG. 2.—*Vickers hardness (Hp 0.3 kg.)/depth curve for an induction-hardened cast-iron component.*

available are mostly insufficient. The graphite does not take part directly in the hardening and appears in the micro-structure of the hardened grey cast iron in the martensitic matrix. It influences the hardening results indirectly, however, inasmuch as occasionally with too prolonged a heating, the graphite can burn out on the surface. On the other hand, graphite inclusion can give rise to stress points in the cast iron. Crack-free hardening is achieved if the stress peaks occurring during the hardening are held within a tolerable limit and particularly by achieving compressive stresses in the martensitic matrix.

Phosphide eutectic is the last constituent to solidify during the freezing of the casting and on heating it is also the first constituent to become fluid again; its melting point is about 950 deg. C. If this temperature be exceeded during the hardening, then the phosphide eutectic melts and the compression stresses which occur during the heating of a surface layer press the fluid constituent out. With the subsequent quenching, this constituent then remains lying on the surface in the form of more or less fine particles or beads. In the structure of the surface layer in its place there are formed hollow spaces which become visible on grinding. There are two ways of avoiding this: The use of a very low phosphorus iron or by keeping the temperature below 950 deg. C. The second way is the only practical one. In order to be able to use as broad a temperature range as possible for the hardening, a content of 0.89 per cent. of combined carbon is preferably sought. The requirements for satisfactory induction hardening of grey cast iron, and particularly as regards the maintenance of the required hardness-penetration depth, are dependent on electrical constants, but in finality also upon the structural constituents of the iron-graphite, pearlite (and under some circumstances ferrite). It is less a question of composition—this is fairly easy to arrange—but rather a far-reaching uniformity from casting to casting (and also in the interior) which is desired. The depth/penetration hardening curve is shown in Fig. 2.

Distortion

Distortion is more liable to appear with surface-hardened parts than with full-hardening. The causes for this are the reversible stresses occurring with martensite formation, and to a much greater extent the effect of heat stresses. A temperature gradient of 700 or 800 deg. C. can occur within less than half-an-inch of thickness.

As differential expansion at the various temperature zones is not possible, the result is stresses which lead to plastic deformations. These deformations persist after the quenching and appear as distortion. Such distortion can be of significant importance in the case of the hardening of centre-lathe beds. As subsequent machining is conducted by grinding on bed-grinding machines the machining cost is high and the grinding time required is directly related to any distortion present. Also, the hardened layer cannot be ground away beyond a certain limit unless the hardening effect also is to be lost. A solution to the problem is either a greater hardening depth, to which here again there is a practical limitation or pre-stressing either by hardening or by planing.

Conclusion

The induction hardening of cast-iron centre-lathe beds can now be regarded as a practical operational procedure, but it must be stressed that success can only be achieved provided there is the maximum uniformity in the cast iron; itself a requirement which can only be met by modern foundries. Of various factors, distortion if excessive may be regarded as one of the most serious and if excessive can render the process uneconomic due to unduly-high grinding costs.

Major Expansion Programmes

Aluminium, Limited

Plans have been announced in Montreal to expand the capacity of the new aluminium smelter of Aluminium, Limited, at Kitimat by an additional 60,000 tons of ingots annually. This represents an increase of 65 per cent. on the present rated capacity of the plant. Authorization has also been given for the ordering and installation of a fourth generator of 140,000 h.p. capacity for the Kemano powerhouse.

Approximately $45,000,000 is estimated as the capital requirements for the expansion programme, excluding alumina facilities, to be spent in 1955 and 1956. The company is studying tentative plans to raise $40,000,000 next year from the proceeds of an offer to shareholders.

Ford Motor Company, Limited

An expansion programme involving £65,000,000 in the next five years is announced by the Ford Motor Company, Limited, which, it is expected, will be financed from the company's own resources.

Demand for the company's comprehensive range of products continues to outpace capacity to supply; the scheme entails an increase in floor space of about 4,000,000 sq. ft. and modernization and re-equipment of existing facilities. The programme includes the construction of a new foundry and press shop, and expansion to manufacturing and assembly facilities.

One of the features of the project is the development of satellite factories around Dagenham, including machine shops at Basildon New Town, a spare parts depot at Aveley (Essex), and certain buildings at Woolwich Arsenal.

Correlation of the Properties of Castings and Test-bars in Grey Cast Iron*

Discussion of the Paper by Erik O. Lissell and Morris Itzel

When the above Paper was presented at the annual conference of the Institute of British Foundrymen, Dr. A. B. EVEREST, the chairman, introducing the authors, complimented them on their courage in coming to this country from Sweden to talk to British foundrymen.

After Mr. Lissell had presented the Paper, the following discussion took place.

International Implications

THE CHAIRMAN submitted that the Paper was very timely and very important, in view of the fact that the British Standards Institution were now bringing up for revision B.S. 1452 for grey-iron castings, and also because the subject was now coming up for consideration on the international plane under the International Standards Organization. Mr. Lissell was serving with him on the international committee for testing cast iron, where his contributions on the subject of test-bars were received with great respect.

A number of outstanding points had to be considered by all the committees, and when the British Standard came up for revision the committee would have to re-consider the grading of bar sizes at each strength, particularly whether the specification should continue to compromise or lean more towards the American idea of having one strength for all bar sizes, or have different strengths for one grade of iron as the bar size was altered. Mr. Lissell's contribution would help to "clear the air."

MR. P. A. RUSSELL wrote that he could sympathize with the Authors' desire to get away from the multiplicity of test-bars in the British and other grey-iron specifications, and agreed that most foundries would standardize on one size of bar for their own control tests, but it would be found that the 0.875-in. bar suited some foundries and the 1.2-in. bar others, according to the type of casting being produced.

The Authors, in common with many who have taken part in discussions on the British grey-iron specifications, took far too much notice of a series of different-size bars cast from one ladle of metal, which was *not* the basis of the British specifications. The latter were designed to ensure that a foundry used a different type of iron for castings of differing section thickness and examination of the Authors' Fig. 5, showed that the requirements of the British specifications for large-section castings were much more stringent than those of the German or Swedish specifications. The American specification went to the other extreme by demanding equal strength in all test-bar sizes. The British view on this was that it failed to take into account the inherent weakening effect of large section size on all cast metals.

The data produced by the Authors in Table IV on relative strength in different sectional thickness was, of course, of great value to designers, as obviously the metal in any one casting must be all of one composition. He suggested, however, that the figures for strength in heavy sections were unduly pessimistic, particularly as it was well known that, as the quality of grey iron was improved, particularly by inoculation or alloying, so the section sensitivity decreased.

Test-bars for Heavy Castings

MR. LISSELL replied that certainly there were cases where it would be difficult to use the 30-mm. bar, especially when producing very heavy castings of very low silicon content. However, in Sweden those cases were so very few that they did not take them into constant consideration. He believed there were more foundries in this country which produced very large castings than was the case in Sweden. On the other hand, in a very heavy casting, there was a difference of strength from the surface to the centre, so that it was quite difficult to decide what was the strength of the casting and at which portion a certain strength was called for. In many cases with big castings, especially those for Government purposes, test-bars were trepanned out of the centre, and there was prolonged discussion before the buyers were really convinced that the castings were all right. In one special case a very heavy block delivered to the Swedish electricity board was tested in such a way. The test-bar value was below half of that specified. A separately-cast test-bar would undoubtedly have attained the specified value.

Concerning the second point raised by Mr. Russell, he agreed that the test values for the higher grades in the heavier sections seemed somewhat low. The reason was that the scatter of the plotted results for the higher grades was much greater than that for the lower grades, and therefore, when considering the problem statistically, as the Authors had done, relatively—lower values were obtained—for the heavier sections in the higher grades than in the lower grades.

DR. H. T. ANGUS said that he was glad that Sweden had followed most of the other industrialized countries of the world in setting a specification for cast iron. The provision of a specification was always of advantage to the industry of the country, since it defined more precisely the material that had to be produced. It was satisfactory that in spite of the divergence in detail practically all the national standards regarded the 1.2-in. or 30-mm. dia. bar as the primary standard.

* Paper printed in the JOURNAL, July 15, 1954.

Correlation of the Properties of Castings and Test-bars in Grey Cast Iron—Discussion

Cooling Rate to Volume Ratio

It was noted that the Authors had adopted the assumption that the cooling rate of a casting was proportional to the volume/surface-area ratio. That was an error, although not a serious one, over the range of bar sizes quoted. Fig. A shows the time required for cooling taken from published cooling curves in relation to the volume/surface-area ratio of the casting, and it will be seen that this confirms Chvorinov's* Rule, which states that the time taken for freezing varies as $(\frac{V}{A})^2$. The range over which the Authors' results were taken was in the lower part of the curve, where the error was not very significant, but with heavy sections the error became substantial.

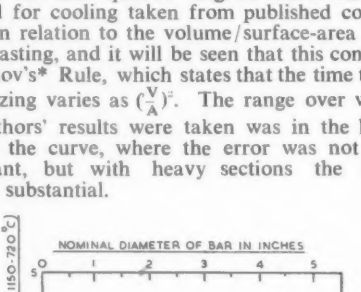


FIG. A.—*Cooling rate (actual) to volume/area ratio for cast iron.*

Similarly, the Authors had assumed that the effect of the diameter of a test-bar on cooling rate was in direct proportion to twice the thickness of an infinite flat plate, and implied that the strength varied directly with the ratio D/2T; again, Dr. Angus did not agree. In the Paper by Dunn, Marles and the speaker,[1] published in the *Transactions* of the American Foundrymen's Society for 1949, the assumption was made that a test-bar of twice the section of a flat plate would give equal strengths in the centre, but in the second Paper,[2] published in the *Proceedings* of the Institute of British Foundrymen in 1952, they had modified that assumption, and had stated that in general, in sections of about 3 in. and above, a test-bar of the same diameter gave roughly the same strength in the centre. They had based that statement more on experience than on theory, and believed that many would substantiate it.

He was very interested in the Authors' curve showing the hump at the standard test-bar point. That was purely an artificial hump, as had been shown, and it would occur at any point where a standard test-bar was taken. Nevertheless, it was quite important that attention should be drawn to it, since if an industry had standards, it must limit the number of test-bar sizes, and any data drawn from standard test-bar figures must be subject to that interpretation. While he was inclined to think that it was somewhat artificial to include the humped curve in a specification, in view of the known scatter that was obtained, it would undoubtedly serve as a corrective to those who imagined that the provision of material which gave a particular tensile in one section-size automatically assumed that the tensile in another section could be predicted precisely.

Dr. Angus added that he did not agree with Mr. Russell's statement that the figures given by the Authors relating to strength in the centre of heavy sections were pessimistic. Different irons had different strength/section characteristics, and if a specification set out to indicate this variation, it was preferable to err on the low side in calculating the potential strength.

MR. LISSELL said he was quite sure Dr. Angus was right in his remarks regarding the relationship between different size plates and bars; but he and his colleague were aware that they had put forward a very crude approximation. Even if the designers knew the relationships between simple shapes very well they could not calculate real values in complex castings. So that, considered from a recommendation point of view, such assumptions as had been made in the Paper could be accepted, although they were certainly not absolutely correct.

The humped curve was not a true correlation curve; the true correlation curves were smooth, and certainly the humped curve was more or less a statistical approximation; when working with a bar of one ruling size, with a restricted scatter, there must be a larger spread at the sides. He stressed, however, that the humped curves were not specifications, but just recommendations to show designers that they could not expect a strength higher than a certain value if there were a round section included in their design; the Authors had assumed what would be obtained under ideal conditions. It was necessary to take into consideration the scatter that always occurred and to try to obtain as much information as possible with regard to the scatter, both for very simple and more complicated shapes.

Interpretation

MR. J. E. O. LITTLE said it was stated in the Paper that the correlation of test-bar to casting was giving the industry very great concern; that was a thought which those who served on the Institute's sub-committee had well in mind. In relation to

* Chvorinov: *Giesserei*, 1940, **27**, 177.

the curves, the 1.2-in. or 30-mm. dia. bar was on the relatively steep slope of the curve, and it occurred to him that very little difference in the temperature of casting or in the size of the bar could alter that considerably. If there was an 18-ton iron on a 1.2 bar, was it right to call it an 18-ton iron? At the other end of the curve the tail was very nearly flat. Would not that be the correct strength to give for the iron, in the sense that it could not be any lower? He believed that the very-low end of the curve was a true reflection of what the engineers thought of the castings. Basically, engineers thought founders were rogues and vagabonds, anyway, and when they designed a casting, engineers would thicken a section, though it would not necessarily increase the strength of a casting, to what they had in mind, and when they asked what strength it had, the founders could not tell them.

MR. LISSELL said that in the very thin sections, as compared with the bars of larger diameter, the strength increased and at the same time there was greater scatter. He did not know whether Dr. Angus would agree that high-strength iron was apt to give more scattered values.

Tensile *v.* Transverse Bars

MR. R. REDPATH commented that he would like to hear more of the relationship between types of test-bar specifications. The discussion so far had been concerned with tensile tests and tensile test-bars, whereas the subject of the paper was the correlation of the properties of castings and test-bars in grey cast iron. He suggested that the transverse bar, as cast, gave a truer picture of the properties of the casting than the tensile bar, which was tested after turning away some of the cast material.

The reason he raised the point from the practical angle was that very often, and particularly with an unalloyed cast iron, it was possible to meet transverse test-bar requirements quite easily, whereas when a tensile bar had been made and was turned down it was sometimes not quite so easy always to meet the tensile requirements. He asked the Authors whether the machined tensile bar gave a correct picture of the casting, in their opinion, or whether the transverse test-bar, as cast, gave a better representation.

MR. LISSELL replied that no test-bar gave the real answer in regard to the properties of the casting. He believed the reason why the tensile bar was generally adopted was that it gave a fairly simple stress pattern, whereas in a cast-iron transverse bar the neutral line was shifted and it was therefore very difficult to calculate on the basis of a transverse value; it did not give a figure which the designer could use.

On the other hand, it was easier to cast a short test-bar than a long one, because in the shorter bar the centre-line shrinkage could be avoided—a remark which further mitigated against the transverse bar. He personally did not, however, see any reason why one should not use a transverse bar as a control test-bar. If the relationship for any special iron was known, with regard to the grade, there was no reason why the transverse bar should not be used.

MR. T. B. BURROWS said the title of the Paper was most intriguing; a very great deal of research had been devoted to trying to relate test-bars with castings. Dr. Angus had mentioned that heat-transfer affected the ultimate strength in heavy castings, and one felt it would be agreed that casting temperature played a very important part in determining the ultimate structure of the casting in the various sections. However, Mr. Burrows asked the Authors if they had any statistical information on the casting temperatures of test-bars, from the point of view of correlation. Could they give any information from experience on whether the casting temperature of the test-bar bore any relationship to the ultimate strength, particularly in relation to the section it was supposed to represent?

MR. LISSELL commented that to answer the question properly meant another entry into a very wide field for research. As to the test-bar curves, he said that in casting the bars the Authors had tried to obtain as much scatter as possible in order to achieve their objective, so that all bars were not cast at a given temperature; temperature effect was included in the scatter.

He appreciated that that did not answer the question, but that was all the Authors had done about it, and there was a great need for further research. Much work had been done and was being done on the influence of temperature on the test-bars—superheat, casting temperatures, etc.—a great deal more was required.

Swiss Results

MR. H. MORROGH said he had no comments to make on the subject matter of the Paper, but in the course of the discussion several members appeared interested in the mechanical properties actually obtained in iron castings. He had not worked on this subject but it seemed that the results obtained by the Swiss worker, Collaud, which were very largely overlooked in this country, could provide useful information.

Collaud had demonstrated the rather simple relationship between the Brinell hardness number and the tensile strength of materials cast in various sections. He had cast test-bars of various sections and determined the tensile strengths and Brinell hardnesses, and he had made castings of various section sizes from the same metal, and was able to show that for practical purposes there was a linear relationship between the hardness and tensile strength obtained. If one carried out tensile and Brinell hardness tests on two or more test-bars of different section size and then determined the tensile/Brinell hardness relationship, one could obtain an estimate of the tensile strengths of castings of various section sizes by merely determining their Brinell hardnesses. Mr. Morrogh said he did not suppose the result was very accurate but the method provided a useful guide.

Causes of Scatter

MR. H. G. HALL asked, in view of the Authors' wide experience with all types of test-bars, whether they could state the major causes of scatter in test-bar results.

Correlation of the Properties of Castings and Test-bars in Grey Cast Iron—Discussion

MR. LISSELL replied that when several test-bars were cast from different melts they did not have the same chemical composition every time and the test-bars were never perfect. There was scatter due to the different testing apparatus, due to different composition, due to the machining programme and to imperfections from cast to cast; so that there was no reason why there should not always be scatter when testing.

The Dübi-Collaud idea was a very good one for trying to solve the problem of correlation between bar and casting. From what he had read, the irons were standardized, and the hardness in various section thicknesses known. The trouble that one experienced, otherwise, in taking test-bars every time, could be overcome if one adhered to the same kind of practice and checked frequently. Just to check the hardness at certain points of the castings made from irons which were specified was to simplify the whole matter. However, in the case of a heavy casting, the hardness on the surface would not give the actual strength of the casting at the point where the hardness was checked; but for most cases the Collaud method was one acceptable way of trying to solve the problem of correlation between test-bar and casting. The iron must be kept under very-closely-controlled conditions, however, if it was desired to use that method.

MR. D. FLEMING, on the question of relating the assumed tensile strength of a casting to the Brinell reading, said that in his particular field normally one type of iron was used, and it was the intention day-by-day to make that iron reasonably the same. There were unavoidable differences due to variations in raw materials, melting technique, casting temperatures, lack of accuracy in control methods and lack of accuracy in testing methods; but having seen thousands of results relating to what purported to be one class of iron, he would never accept that it would be safe to assume a certain strength in a particular case from a particular Brinell reading in everyday practice for high-prosphorous grey iron.

MR. H. G. HALL commented that surely the previous remarks applied also to materials other than cast irons.

Vote of Thanks

THE CHAIRMAN (Dr. Everest) proposed a hearty vote of thanks to the Swedish Authors for presenting such an interesting Paper and for handling the discussion so well. The members really appreciated their Paper, he assured them, and attached a great deal of importance to it. Already he had drawn the attention of the Institute's test-bar sub-committee to the matter and the Paper would be studied in relation to the revision of specifications. Undoubtedly, the Authors' work would be considered in connection with the international standards, which were now receiving attention.

REFERENCES*

[1] Angus, H. T., Dunn, F., and Marles, D. Properties of Cast Iron in Relation to the Carbon-equivalent Value. *Trans.* A.F.S., 1949, **57** 24-43.

[2] Angus, H. T., Dunn, F., and Marles, D. *Ibid. Proc. Inst. Brit. Foundrymen*, 1952, *XLV*, A.57.

* Quoted in discussion by Dr. Angus.

Need for "Ideas Men" in Industry

One senior man in every company should be responsible for searching out and introducing new ideas to the firm. That is the message of the "Ideas in Action" exhibition which has been opened at the Birmingham Museum of Science and Industry. The exhibition offers suggestions for the ways in which the "ideas man" can find out what is latest and best in the world of scientific invention by reading the technical journals and research papers, studying the customers' needs, following the activities and seeking the help of trades associations, and by applying to the Department of Scientific and Industrial Research, which, with the Central Office of Information and the Birmingham Productivity Association, is sponsoring the exhibition.

Major C. R. Dibben, chairman of the Midland Regional Board for Industry, opened the exhibition and welcomed it because of its "fresh angle" on the old problem of increasing productivity. D.S.I.R. was not sufficiently known to industrialists and there was inadequate appreciation of what it could and would do, to help firms, he said. Time and again there must arise in any manufacturing concern, whatever its size, but particularly among smaller firms with limited resources on the scientific and research sides, problems beyond their capacity to solve, and greater use of the facilities readily available to them through D.S.I.R. would be of undoubted good, both to them individually and nationally.

"Consolidated" Retirement

Mr. J. U. Vass, who began work as a fitter and rose to be works manager and a director of the Consolidated Pneumatic Tool Company, Limited, Fraserburgh, retired last weekend after 44 years with the firm and was honoured by his co-directors and employees. Mr. Norman Readman, managing director, presented him with a television set and Mrs. Vass a handbag. In addition, Mr. Vass received a replica of the Fraserburgh works flagstaff, made by the men themselves, and handed over by Mr. James McRae, and a bound book of the signatures of those who contributed to the main gift. Over 1,000 employees attended the ceremony in one of the workshops, and the company also included the three London directors and their wives—Mr. and Mrs. Readman, Mr. and Mrs. J. A. Owen, and Mr. and Mrs. R. C. King. The managers of the Brussels and Melbourne branches—Mr. S. C. Thaine and Mr. A. R. Jackson—were also present. Tributes came from the parent body in Chicago and from branches in South Africa, Australia, India, Pakistan, France, Belgium, and Italy.

Mr. Readman paid tribute to Mr. Vass's work, and said that no one in the organization had rendered more signal service. He recalled Mr. Vass's career since entering the works in 1910. A letter from the president of the Chicago Pneumatic praised the manner and the spirit in which the Fraserburgh factory had been conducted under Mr. Vass's management, and expressed indebtedness for his loyalty and achievements.

Titanium

Production in Britain by New Process

Fifty of the senior technical staff of the British aircraft industry recently attended a conference arranged by Imperial Chemical Industries, Limited, at one of their Birmingham factories to discuss the properties of titanium and its alloys, the problems of handling and joining the material, and questions of its availability. They witnessed melting and preliminary fabrication in a pilot plant, saw the progress made in the construction of a large-scale melting plant, and were shown specimens illustrating titanium's outstanding properties of corrosion-resistance.

In the course of the conference it was confirmed that the process I.C.I. has developed uses sodium in the reduction of titanium tetrachloride. Their main plant, which is in an advanced stage of construction and will be in operation within the next six months, will thus be the first large-scale production unit to operate a process other than that devised by Dr. Kroll, which came into prominence, particularly in the U.S.A., after the war.

Selection of Method

The General Chemicals Division of I.C.I., who are responsible for making the raw titanium sponge, started research on this metal some years ago, and investigated many processes, including the reduction of titanium tetrachloride by magnesium and by sodium, electrolysis of various salts, and direct reduction of oxides. After a considerable amount of exploratory work had been done and many of the processes had been eliminated, either because they seemed impracticable to apply on a large scale or because the product was unsatisfactory, I.C.I. decided that the reduction of titanium tetrachloride by sodium was the most promising process, especially for British conditions, and that it was likely to give good-quality material at a price competitive with that of any other known process. Therefore, although I.C.I. erected, and is working, a titanium plant using the Kroll process (reduction of titanium tetrachloride by magnesum) in order to have some material available, most of its effort has been directed to the reduction of titanium tetrachloride by sodium.

This process in its essentials is not new. In fact, it was the method by which titanium was first isolated. It had been stated, however, that this reaction would be uncontrollable on a large scale, and the raw titanium sponge made by the sodium reduction of titanium tetrachloride would not have the necessary properties to allow good-quality, massive ingots to be made. The work in the I.C.I. research laboratories indicated that this was not necessarily true, and that, potentially, the reduction of titanium tetrachloride by sodium was economically attractive.

A semi-technical plant was erected in 1953, and a larger pilot plant was erected and started operation early in 1954. The results obtained on these plants have confirmed the early work, both in the quality of the product obtained and in the efficiency of the process, and have also solved many of the problems connected with the design of a large plant. Such was the faith of the Company in the sodium process that it took the decision to build, and started design on, the large-scale plant late in 1953, well before the pilot plant started operation. This large-scale plant is being built in the North of England, and, construction having gone according to schedule, it is expected that the first units will come into production in the first half of 1955, and that full production will be reached before August.

Present Position

Meanwhile, the pilot plant has worked steadily, and many tons of material have been produced and sold. The product from the plant is in the form of granules, which can be compressed into pellets for melting. After the melting into ingots, the material has a hardness which compares favourably with the product by the Kroll process, and meets the exacting demands of the users. The quality of the I.C.I. product is fully up to requirements in all respects, not only with regard to the specification for hardness—probably the most difficult property to control—but particularly with regard to its freedom from undesirable impurities.

Concurrently with the General Chemicals Division's work on producing raw titanium, extensive research and development work has been done by I.C.I.'s Metals Division on processes for melting and fabricating titanium and its alloys. A pilot plant at one of their Birmingham factories has been melting raw titanium-sponge for some time past at the rate of 150 tons per year, and converting it into ingot, forging stock, and various fabricated products which have been supplied to the aircraft industry. A major plant for melting and preliminary fabrication of titanium and its alloys will be completed early next year, when supplies of strip, sheet, rod, tube and wire, in addition to raw titanium-sponge, ingot, and forging stock, will be available on a large scale for the aircraft and other industries.

The capacity of the full-scale plants which are being erected is 1,500 tons per year. Though this capacity may seem small compared with the announced intentions of American makers, it is not much less than the amount of titanium sponge actually produced in America in 1953 (2,250 short tons), and the plant has been designed so that it can be expanded when required. The whole project is being financed out of I.C.I.'s own resources, although the Government has undertaken to purchase a proportion of the output over the next four years if necessary, at the world prices prevailing.

THERE was a rise of 0.5 per cent. during September to 143.9 in the overall level of prices of basic materials used in industry, as measured by the Board of Trade's monthly index. This advance was largely due to higher prices for copper (up 7.7 per cent.), lead (up 4.6 per cent.), zinc (up 7.1 per cent.), and raw rubber (up 2 per cent). The indices measuring the levels of prices of materials used in the mechanical engineering and electrical machinery industries rose by 0.6 and 1.4 per cent. respectively during September, mainly because of rises in the prices of non-ferrous metal items, particularly copper.

Notes from the Branches

Coventry and District Section

The opening meeting of the Coventry and District section of the Institute of British Foundrymen was held on Tuesday, October 19, at the Technical College, Coventry, when Mr. D. E. Hancox, A.I.M., delivered his presidential address on "Human Relations in the Foundry Industry." This was followed by a most interesting talk entitled "Milestones in Foundry Practice," given by Mr. Vincent C. Faulkner, F.R.S.A., Hon. M.I.B.F.; 70 members and visitors attended the meeting.

This new section was formed out of the old Coventry and District Students' section, which had thrived over the past five years to such an extent that it was decided at National Council level to elevate it to full senior status, the section being affiliated to the Birmingham branch.

Newcastle-upon-Tyne

By invitation of the management, about 100 members of the Newcastle-upon-Tyne branch visited the naval yard of Vickers-Armstrongs, Limited, High Walker, on October 9. The visit proved both interesting and informative. Shipbuilding plays such an important part of the industrial activities on Tyneside that the prosperity of many foundries in the area depends, to a large extent, on the continued pressure of work in the building yards and particularly the marine-engineering shops located on the Tyne.

In many works on the river, the activities embrace both shipbuilding and engineering, and, generally, foundries are included to supply the majority of the castings required. The naval yard of Vickers-Armstrongs at Walker, however, is wholly concerned with shipbuilding, the main and auxiliary machinery being obtained from outside sources, as well as castings required in ship construction.

This yard covers a very large area and, at the initial stage of the visit, members got an excellent idea of its layout from a scale model located in the main hall of the office buildings. In keeping with present-day practice, in which welding plays so important a part, large shops are laid out and equipped for sectional building, thus reducing the amount of work formerly carried out on the stocks.

After inspecting many of the shops and the mould loft the members were shown along the quay, alongside of which were berthed several vessels, including the Furness Withy liner Ocean Monarch, a vessel of 13,654 tons, which was completed in this yard in 1951 and was (at the time of the visit) in for a three-week refit, this vessel was expected to sail the following week to resume services from New York.

Ships under Construction

The stocks were next visited and it was noted that four vessels were in various stages of construction, included amongst which was a frigate. However, the ship which received most attention was a 28,000-ton tanker which is expected to be launched in December. This vessel was sufficiently advanced to see the amount of work involved in its construction. The oil tanker is probably the only type of cargo ship not fitted with a double bottom. The cargo space is divided and subdivided to form many tanks, which must be watertight, and the cargo comes directly into contact with the bottom plates of the ship.

In thanking the officials who had acted as guides to the visitors, Mr. C. W. Stewart, the branch president, said the members were very grateful for the opportunity of seeing this naval yard, where so many great ships had been built, and to note from its activities that it continues with undiminished energy in those more difficult times. From a foundryman's point of view he was concerned about the progress being made by welding and felt that, perhaps, in that direction there might be a lesson to which foundrymen might give careful thought, with a view to improving their own products.

(*Continued at the foot of col.* 2)

Trade with China

Visits by two large groups of British businessmen to China are expected to take place towards the end of this year and the beginning of next. Arrangements are being made by the Sino-British Trade Committee which was set up earlier this year.

Lord Boyd Orr recently told the British Council for the Promotion of International Trade, of which he is president, that Chinese orders estimated at £8,000,000 had been lost last year because of continued restrictions. It was stated at the conference of the Scientific Instrument Makers' Association on October 15 that there was going to be an enormous potential for the industry's products in China and it was urged that something should be done about the large amount of embargoed equipment. It was also alleged that while certain items could be exported to Russia and not to China, there was nothing to stop Russia sending them there.

A further plea for relaxation of trade restrictions with China has been made by the General Council of the Scottish Trades Union Congress in its decision to approach the North British Locomotive Company, Limited, to try again to secure orders.

The unions involved in locomotive manufacture had made representations to the Board of Trade on the question of redundancy, but the Minister of State had no evidence that China was prepared to place an order for 500 steam locomotives, although, of course, exports were embargoed under the 1951 international agreement. The General Council felt that the opportunity of lifting the embargo would be greater if firm orders could be produced.

Renishaw Developments

The Renishaw Iron Company, Limited, near Sheffield, which have been in existence at Renishaw since 1782, and are said to be the oldest makers of foundry pig-iron in the country, will relight their No. 2 blast furnace, which has been relined, on October 28. They will also bring into commission, as part of a £500,000 project which has occupied the last two years, a new raw-materials-handling installation. A third furnace which is being built will be completed next year. The new installation will feed the raw materials into all three furnaces.

Before the No. 2 furnace is relighted, there will be a religious service around it in accordance with tradition, and it will be blessed by the Rector of Eckington, the Rev. C. S. Branson. The relighting ceremony will be carried out by Mrs. F. Wood, the wife of a director, and the new installation will be set in motion by Mrs. Draycott, wife of Mr. H. Draycott, director and secretary. Mr. J. F. Stanier, chairman and managing director since 1940, is returning from Australia with his wife for the occasion.

Pig-iron and Steel Production

Statistical Summary of August Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table I summarizes activities during the past seven months. Table II gives production of steel ingots and castings in August, and Table III, deliveries of finished steel in July, 1954. Table IV gives the production of pig-iron and ferro-alloys in August, 1954, and furnaces in blast. (All figures weekly averages in thousands of tons.)

TABLE I.—*Iron and Steel Price Index and General Summary of Pig-iron and Steel Production.*

Period.	Price Index, 1938 = 100.			Iron-ore output.	Imptd. ore used.	Coke to blast-furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy).			
	I. & S.	Coal.	All comdts.						Imports.[1]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[2]
1952[3] ..	254	329	323	306	190	228	202	171	29	310	252	683
1953	260	350	323	304	207	237	215	188	18	339	262	962
1954—Feb. ..	259	359	322	302	230	240	222	201	14	357	290	902
March[4]	260	360	324	322	232	238	231	203	16	365	291	898
April ..	260	360	325	312	236	243	232	200	4	368	272	945
May ..	261	365	326	306	236	240	231	208	4	375	288	927
June[4]	265	365	328	289	239	240	233	204	4	372	274	1,011
July ..	265	365	328	284	213	227	211	142	4	263	216	1,078
August	265	365	325	266	238	237	227	177	5	326	—	1,128

TABLE II.—*Steel Ingots and Castings during August*, 1954.

District.	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derby, Leics., Notts., Northants and Essex ..	—	3.2	11.2 (basic)	1.4	0.2	15.4	0.6	16.0
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire	1.0	23.5	—	1.2	0.4	25.1	1.0	26.1
Yorkshire (excl. N.E. Coast and Sheffield) ..								
Lincolnshire	—	39.8	—	—	0.1	39.8	0.1	39.9
North-East Coast	2.0	61.7	—	0.9	0.3	63.6	1.3	64.9
Scotland	2.7	38.4	—	1.1	0.6	41.3	1.5	42.8
Staffs., Shrops., Worcs. and Warwick	—	14.6	—	1.0	0.5	14.6	1.5	16.1
South Wales and Monmouthshire	2.3	63.6	6.5 (basic)	0.7	0.1	72.7	0.5	73.2
Sheffield (incl. small quantity in Manchester) ..	6.4	27.7	—	7.3	0.4	40.3	1.5	41.8
North-West Coast	0.3	0.3	3.8 (acid)	0.3	0.1	4.7	0.1	4.8
Total	14.7	272.8	21.5	13.9	2.7	317.5	8.1	325.6
July, 1954	13.3	211.6	21.1	14.6	2.5	254.9	8.2	263.1
August, 1953	14.9	242.3	17.0	14.4	2.8	282.6	8.8	291.4

TABLE III.—*New Non-alloy and Alloy Finished Steel.*

Product.	1952.**	1953.	1953.	1954.	
			July.	June.*	July.
Non-alloy steel:					
Ingots, blooms, billets and slabs[5]	4.5	4.7	3.8	5.5	3.6
Heavy rails ..	8.0	8.7	7.8	9.7	8.2
Sleepers, etc. ..	1.8	2.2	2.5	2.0	1.3
Plates, 3 mm. thick and over ..	41.4	46.5	42.6	46.1	31.3
Other rolled prod.	39.0	43.9	32.5	46.9	34.8
Wire rods, rods, bars, coiled ..	15.9	15.6	9.6	19.2	12.2
Light rolled prod.	46.0	49.3	39.9	47.5	38.2
Bright steel bars ..	6.5	6.7	6.1	5.6	5.1
Hot rolled strip ..	18.8	18.8	15.2	*20.7	17.3
Cold rolled strip ..	6.1	5.2	3.8	7.2	5.9
Sheets, incl. coated	31.7	34.1	29.9	39.1	32.5
Tinplate, terneplate and blackplate ..	16.0	14.9	13.9	17.8	14.9
Steel tubes, pipes	20.1	20.1	18.4	19.8	18.1
Tube, pipe fitgs.	0.4	0.3	0.3	0.4	0.4
Tyres, wheels, axles	3.5	4.4	3.9	3.7	3.7
Forgings (excl. drop forgings) ..	2.8	3.1	2.6	2.5	2.2
Steel castings ..	4.2	4.0	4.0	4.1	3.0
Tool and magnet steel	0.3	0.3	0.3	0.2	0.2
Total	267.0	282.8	237.1	299.0	232.9
Alloy steel	13.4	13.7	12.0	12.7	10.5
Total deliveries from U.K. prod.[6] ..	280.4	296.5	249.1	311.7	243.4
Add: Imported finished steel ..	12.9	6.8	5.1	2.2	2.4
	293.3	303.3	254.2	313.9	245.8
Deduct: Intra-industry conversion [7] ..	42.7	42.6	34.2	40.9	30.7
Total net deliveries of new material ..	250.6	260.7	220.0	273.0	215.1

TABLE IV.—*Pig-iron and Ferro-alloys during August*, 1954.

District.	Furnaces in blast.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants and Essex	25	2.1	17.2	20.9	1.1	—	41.3
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire ..	6	—	14.7	—	—	0.7	15.4
Yorkshire (incl. Sheffield, excl. N.E. Coast) ..							
Lincolnshire ..	10	—	34.6	—	—	—	34.6
North-East Coast	23	4.4	45.4	0.1	—	1.3	51.2
Scotland	9	0.8	15.9	1.7	—	—	18.4
Staffs., Shrops., Worcs., and Warwick ..	9	—	8.4	1.4	—	—	9.8
S. Wales and Monmouthshire	9	4.7	33.1	—	—	—	37.8
North-West Coast	7	17.4	—	—	—	1.5	18.9
Total ..	98	29.4	169.3	24.1	1.1	3.5	227.4
July, 1954 ..	95	27.5	152.5	27.4	0.6	3.2	211.2
August, 1953 ..	105	25.2	150.8	23.4	1.2	3.8	204.4

[1] Weekly average of calendar month.
[2] Stocks mainly ingots and semi-finished at the end of the years and months shown.
[3] Average 53 weeks ended January 1953, all tables.
[4] Five weeks, all tables.
[5] Other than for conversion into any other form of finished steel listed
[6] Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.
[7] Material for conversion into other products also listed in this table.

Personal

MISS C. J. HANSON, a director of the Molyneux Foundry Equipment Company, Limited, and one of the few lady members of the Institute of British Foundrymen, was married last Saturday to Mr. Bob de Heus.,

MR. JOHN HOWARD WEAVER has been appointed export sales manager of the Rover Company, Limited, Solihull. He previously held an executive post with Tozer, Kemsley & Millbourn, Limited, on the automobile side of the business.

MR. GEOFFREY LLOYD, P.C., M.A., M.P., is to be the principal speaker at the dinner/dance/cabaret organized by the British Bronze and Brass Ingot Manufacturers' Association to be held on November 6 at Grosvenor House, Park Lane, London.

STANTON IRONWORKS COMPANY, LIMITED, announce the following appointments: MR. G. R. BUCKLEY to be general works manager; MR. E. MORGAN to be general manager in charge of research; MR. L. RAWLINS to be commercial manager; and MR. J. D. HICKMAN to be export manager.

MR. PIERRE CHEVENARD has been nominated a *Commander of the Legion of Honour*, and MR. PAUL MUGUET an *Officer of the Legion*. Both are past-presidents of the *Association Technique de Fonderie*. To these well-known gentlemen are offered warm congratulations from British foundrymen.

MR. DOUGLAS F. WALTON, local director of Thos. W. Ward, Limited, Albion Works, Sheffield, has been appointed director of the Ketton Portland Cement Company, Limited, a subsidiary company. He is also a director of the Darlington Railway Plant & Foundry Company, Limited, another subsidiary of Ward's.

MR. ALBERT GEORGE COLTMAN, has been elected an associate member of the Institute of Mechanical Engineers. He is an engineer in the textiles department at British Celanese, Limited, Spondon, formerly he had been with Rolls-Royce, Limited, Derby, the Electrical Furnace Company, Burton-on-Trent, and Baguley, Limited, locomotive engineers, Burton-on-Trent. Mr. Coltman was an indentured apprentice with F.N.F., Limited, Burton-on-Trent.

BRITISH EMPIRE MEDALS were received by Sheffield workers from the Earl of Scarborough at ceremonies on their firm's premises on October 22. Included among the recipients was MR. GEORGE WILLIAM MOORE, 62-year-old patternshop supervisor for Millspaugh, Limited, engineers, of Alsing Road. He has been with the firm since it was founded 21 years ago. Speaking to the 500 workers who had gathered in the foundry for the ceremony, Mr. Moore said the award was an honour not only to himself but also the firm and its team of workers.

MR. FRANK WHITEHOUSE, works manager of James Howden & Company, Limited, engineers, Glasgow, has been appointed general works manager of the heavy construction department of Newton, Chambers & Company, Limited, Thorncliffe, near Sheffield. He is a native of Bury, Lancashire, and was an extra-mural lecturer in foundry practice at Sheffield University, and previously served with Newton Chambers from 1932 to 1940, when he went to Glasgow. He is a member of the Institute of British Foundrymen and of the Institute of Works Managers.

DR. RICHARD BEECHING has been appointed chairman of the Metals Division of Imperial Chemical Industries, Limited, in succession to Mr. C. E. Prosser, who is retiring from the company's service. The appointment dates from February 1, 1955. Dr. Beeching, who is 41, graduated from the Imperial College of Science and Technology with first class honours in physics. After gaining his doctorate he spent five years with the Mond Nickel Company, Limited, and, during the war, rose to be deputy chief of the armaments design department of the Ministry of Supply. He joined I.C.I. in 1948 and became technical member of the "Terylene" Council in 1951. As a director of I.C.I. of Canada, Limited, since 1953, he has been responsible for the development of the new "Terylene" plant at Millhaven, Ontario. Mr. Prosser has, throughout his career, played a prominent part in the counsels of the non-ferrous metals industry. He was appointed to the Board of I.C.I. Metals Division in 1936 and became chairman in April, 1953.

Obituary

MR. WALTER WATERFIELD, manager of the machine-shop of William Jessop & Sons, Limited, steel manufacturers, Sheffield, for 33 years until his retirement in 1949, has died at the age of 72. He started work at the age of 14 in the machine-shop and became manager in 1916, and had been with the firm for 53 years. He was awarded the M.B.E. in the 1943 New Year honours list for services to the Admiraty.

THE DEATH is announced of DR. THEODOR GEILENKIRCHEN, who for many years was the Editor of *Die Giesserei*, the official organ of the German foundry technical organizations. He died whilst participating in the Florence International Conference. He was born in 1877 and trained at the Aachen Technical High School. He was a pioneer in the making of electric steel in Germany, but it was as a technical editor that he was best known. Under his capable leadership, *Giesserei* took a very prominent position amongst the foundry technical Press. He was a founder member of the International Committee of Foundry Technical Associations and was a regular participant at congresses held under its auspices. Germany has lost a distinguished foundryman, for so many years a hard-working and erudite leader.

MR. ROBERT MCMORLAND, the oldest employee of the firm of M. Cockburn & Company, Limited, Falkirk, died suddenly at his home, last week at the age of 63. As a boy, he went to the town from Ayrshire and on leaving school entered the office of the foundry firm, where he had been employed for 49 years. After service with the Army in the first world war he returned to the foundry and was employed as personal secretary to Mr. Norman Cockburn, who was at that time managing director of the firm. Shortly afterwards, Mr. McMorland became representative for the company in the East of Scotland until the end of the last war, when he was appointed representative for Glasgow and Edinburgh. He was extremely well liked by his colleagues and was president of the Allied Ironfounders Social & Sports Club.

AMONG the many donations acknowledged by the University of Leeds at a meeting of its Council, was the following:—For the Technology Departments: £73 10s. from the Incorporated Plant Engineers, for the purchase of books for giving help with a refresher course in the departments of civil, electrical and mechanical engineering, and coal, gas and fuel industries.

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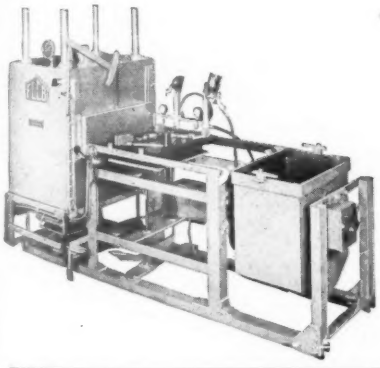

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236/73

News in Brief

THE 28TH CONGRESS of the *Association Technique de Fonderie* is to be held from June 2 to 4, 1955, in Paris.

PHILIPS ELECTRICAL LIMITED announce a new 400-w. mercury-fluorescent lamp for which very much improved colour rendering properties are claimed.

ON OCTOBER 16, Mr. René Coty, the President of the French Republic, visited the works of Pont à Mousson to inspect the latest centrifugal pipe-casting plant.

DOVER PLANNING COMMITTEE has given permission for a substantial addition to the works of the Dover Engineering Works, Limited, by the erection of a new building 104 by 60 ft.

THE EMPLOYEES of Dean, Smith and Grace, Limited, lathe manufacturers, of Keighley, held another of their hobbies exhibitions on October 16, when the works were open to the public.

WHEN 250 volunteers for anti-flu vaccine tests were asked for at the English Steel Corporation, Limited, Sheffield, for this winter, more than 500 came forward. Not all could be accepted.

THE INSTITUTION OF METALLURGISTS held a refresher course at the Palace Hotel, Buxton, from Friday, October 22 to October 24. The subject of the course was "Inspection and Testing of Metals."

AFTER THEIR ANNUAL MEETING at the Nottingham Guildhall, members of the Midland section of the Association of Public Lighting Engineers, paid a visit to Stanton Ironworks Company, Limited, near Nottingham.

LAST FRIDAY, Comm. T. D. Galbraith, Joint Under-Secretary of State for Scotland, formally opened the new Scottish factory of the Luton engineering firm of Hayward Tyler & Company, Limited, at Neston industrial estate in the new town.

LIEUTENANT-GENERAL Sir Ronald Weeks, managing director of the English Steel Corporation, Limited, and other directors was presented to Her Majesty the Queen on the occasion of the Royal visit to the River Don Works, Sheffield, yesterday.

BRITISH INSULATED CALLENDER'S CABLES, LIMITED, announce that on November 1 their Bedford depot is to be closed down and a new depot opened at 81, Dumfries Street, Luton, Beds, 'phone Luton 6866. Mr. W. H. Spillman will be in charge.

WILLIAM JACKS & COMPANY, LIMITED, have appointed Mr. Derek Hall as their travelling representative for North Wales, Cheshire, Lancashire and West Riding of Yorkshire, operating from 13, Rumford Street, Liverpool (tel.: Liverpool, Central 1558).

A. K. FANS, LIMITED, announce that MR. A. W. DEAN from Marconi Telegraph Company has joined the company in an executive position and that they have now taken over further factory space at 352, Goswell Road, E.C.1, for their range of electronic and aircraft axial and centrifugal flow fans.

SIR THOMAS HUTTON, director and secretary of the British Productivity Council, delivered the first lecture, at the Refresher Course for Engineers, on October 19, at Nottingham University. This will be a 20-lecture course, which ends on March 15; many senior works and plant engineers have enrolled.

ROLLS-ROYCE, LIMITED, of Derby, have presented to the Derby Corporation a set of 1,400 crystal glasses—enough to serve 200 people at a banquet with wines, spirits, liqueurs and water. Each glass is engraved with the borough's coat of arms. The gift marks the 800th anniversary of the town's markets and fairs charter.

TWO FILMS about the cranes made by K. and L. Steelfounders and Engineers, Limited, a subsidiary of George Cohen, Sons and Company, Limited, were shown to 200 representatives of Sheffield industry at the Grand Hotel, Sheffield, on October 18. The films showed the cranes at work on sites, and included mobile Diesel, direct-drive and multi-purpose models.

SHEPCOTE LANE ROLLING MILLS, LIMITED, a subsidiary of Firth-Vickers Stainless Steels, Limited, Sheffield, has started a series of five Friday afternoon visits to their new £2,500,000 factory for the husbands and wives of employees. The visits will comprise a two-hour open session when the visitors are to be shown over the plant producing 200 tons of metal sheet each week.

"THANK YOU" notices have been posted on factory notice boards of Guy Motors, Limited, Wolverhampton, in recognition of orders received at the London Commercial Motor Show for vehicles worth £300,000. The management wished to express appreciation to operators for their part in the sales. Colonel Arthur Jerrett, the company sales director, stated that the outlook was extremely healthy.

A NEW electrically-controlled chronometer-type elapsed-time indicator has been designed and placed on the market by Cass and Phillip, Limited, of Mark Road, Adeyfield Road, Hemel Hempstead, Herts, to register the true operating hours of vehicles, engines tractors, rolling-stock, cranes, conveyors, machine-tools and process plant and machinery of practically all types, including remote-controlled and automatically-operated plant and equipment.

HIS GRACE the Duke of Rutland and the Rt. Hon. the Lord Balfour of Inchrye, P.C., M.C., will be amongst the guests of honour at the first annual dinner of the Institute of General Managers to be held at the Savoy Hotel, London, on December 3. Chief executives wishing to attend the dinner, or to receive further information concerning the aims and objects of the Institute should write to the Registrar of the Institute, at 86, Eccleston Square, London, S.W.1.

CASTING DEFECTS are to be the subject of a talk given by Mr. J. L. Francis to the Wales and Monmouth branch of the Institute of British Foundrymen. On November 5, it will be given in Llanelly Technical College at 7 p.m., to the West Wales section, and on the following day to parent-branch members at the Engineers' Institute, Cardiff, at 6 p.m. Mr. Francis, who is president of the Birmingham branch, will use the Institute's "Atlas of Defects," as a basis for his remarks.

AT THE ANNUAL DINNER of the "25 Year Club" of Bryan Donkin Company, Limited (Chesterfield), which was held at the Station Hotel, Chesterfield, new members were presented with a gold watch and a badge, by Mr. Alexander Abel Smith, vice-chairman of the board of directors. This club has now 185 members, of whom ten have over 50 years' service, 48 have more than 40 years', and 65 over 30 years' service with the firm. Last year, 19 new members qualified.

IN RECENT YEARS, Birmingham City Council has established a policy of annually commissioning a piece of modern silver designed by a leading silversmith for use on the Lord Mayor's table on ceremonial occasions. For the current year, the Museum and Art Gallery has commissioned Mr. Stanley Morris to design and make two sets of sugar casters, to be made of silver with applied gold work. Each set is to consist of three casters, the largest being 10¼-in. high.

THE FIRING of the first of a battery of five oil-fired annealing ovens on October 11 at the foundry of

(*Continued on page* 526)

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News in Brief

(*Continued from page 524*)

Chamberlain & Hill, Limited, in Beacon Street, Lichfield, marked the completion of one of the most modern works of its kind. Construction of the foundry began two years ago and production started in August, 1953. Built at a cost of approximately £150,000, the foundry has an output of 100 tons of iron castings per week, principally for the coal-mining industry.

SMITH & WELLSTOOD, LIMITED, Bonnybridge, are to set up a benevolent advisory council. It will give the directors details of any worker who may require help and whose case does not fall within the scope of State benefit. The council will consider applications from past members, widows of ex-employees or their dependants, even though they now live outside the Bonnybridge area. The secretary of Smith & Wellstood, Limited, invites written applications, for submission to the advisory council.

PLANS to open a large copper rolling mill in Canada have been made by Ratcliffs (Great Bridge), Limited, metal manufacturers. Already a 7,000-sq. ft. building has been erected on a 10-acre site at Richmond Hill, 15 miles from Toronto, and an additional building of 20,000 sq. ft. is to be built next year. It is hoped to have the new plant in operation by November, 1955. Labour will be recruited in Canada although a few erection engineers from the Tipton works will go to Canada in June and spend some five months there. Mr. F. R. Ratcliff, joint managing director, is at present in Canada.

TWENTY-FIVE French visitors, members of the *Chambre Syndicate de la Grosse Forge Francaise*, have visited Sheffield steelworks. They were accompanied on their tours by members of the Iron and Steel Institute and the National Forgemasters' Association. On October 14, they visited the English Steel Corporation, Limited, and were welcomed by the managing director, Mr. F. Pickford, who is also president of the Forgemasters' Association. A tour was made of the Siemens melting and forge departments. The next day the East Hecla works of Hadfields, Limited, was toured, and the visitors had luncheon with the directors.

THE WORK of the London group laboratories of the British Iron and Steel Research Association will be open for inspection by anyone interested at 140, Battersea Park Road, London, S.W.11, on Thursday and Friday, November 18 and 19, between 10.0 a.m. and 5.0 p.m. Visitors will be able to see the facilities for conducting research into many aspects of the iron and steel industry's problems, and also learn something of the specific services which B.I.S.R.A. can render firms in the industry. There will be an extensive display of current and recent research projects under various divisions and departments of the organization, illustrated in many instances by test rigs and working or static models.

THE PRODUCTION AND PROPERTIES OF TITANIUM, the element which may become the metal of the future and of tremendous importance for aircraft production, were described by Dr. N. P. Inglis, of Imperial Chemical Industries, when he gave a lecture recently to the Chemical Society in Belfast. The difficulties of producing pure commercial titanium, which is 56 per cent. of the weight of steel, but much stronger, were described. The importance of large-scale production of the metal and its alloys was seen, he said, when one bore in mind the demand in the aircraft and motor-car industries for lighter metal with great strength which was brought about by the rapid development of faster machines. Titanium is the fourth most abundant of the metal ores in the earth's crust, but it is only now that scientists and practical technicians are beginning to solve problems of its commercial production and special uses.

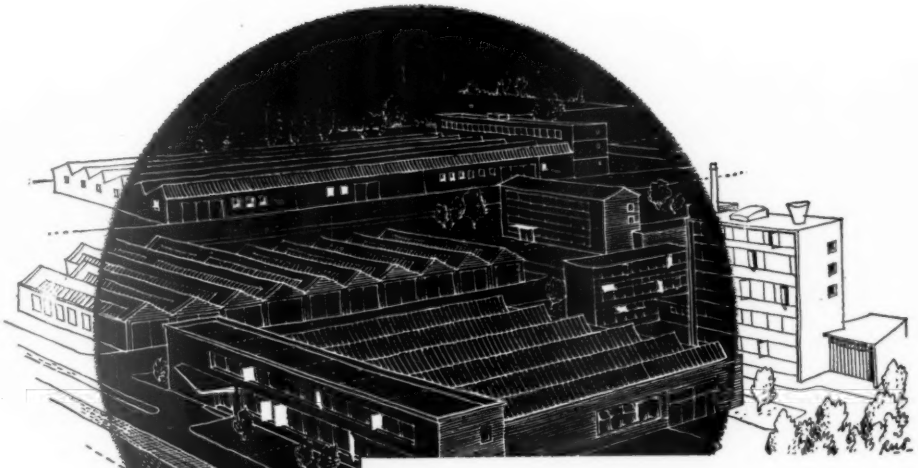
THIRTEEN MEMBERS of a French productivity team arrived in Birmingham on October 20 for a six-day visit to study Midland industry. Arrangements for their visit were in the hands of Professor T. U. Matthew, Professor of Engineering Production at Birmingham University. Six trade union officials, including M. Bapaume, vice-president of the French Confederation of Christian Trade Unions, were included in the team with two employers' representatives and five administrators. Among works visited were Joseph Lucas, Limited, the Austin Motor Company, Limited, the G.E.C., Witton; Radiation, Limited, and the Aston Chain & Hook Company, Limited. At Radiation, Limited, methods were demonstrated of improving productivity in the foundry, machine-shops and assembly operatons by using improved handling equipment and methods. At the Aston Chain & Hook Company, Limited, the team made a special observation of work-study methods and human relations.

METALLURGICAL ENGINEERS, LIMITED, Granite House, Cannon Street, London, E.C.4, state that arrangements have recently been made whereby the manufacture and sale of their hot-blast cupola plants will, as from October 1, be handled by Industrial & Metallurgical Equipment, Limited, of 76, Cannon Street, London, E.C.4 (Telephone: City 7072). Industrial & Metallurgical Equipment, Limited, are an associated company with whom Metallurgical Engineers, Limited, are in close touch and the arrangement has been made as a result of an internal reorganization which should result in greater efficiency. Industrial & Metallurgical Equipment, Limited, will retain the services of Mr. F. C. Evans as their technical adviser and also have the services of the same staff as in the past, so that continuity will be preserved. Metallurgical Engineers, Limited, will design and build the Schack-type recuperator which is incorporated in the hot-blast cupola plant supplied by Industrial & Metallurgical Equipment, Limited.

Pressure Die-casting Conference

The International Pressure Die-casting Conference was held in London from October 25 to 27, the following Papers being presented: "Desirable Trends in Die-casting Machine Development," by H. R. Haah (Dyson & Company Enfield (1919), Limited); "Technical Testing of Die-castings," by G. Lieby (Mahlewerk GmbH, Germany); "Comparison of Die-casting with Machining, Pressing and Plastic Moulding," by H. Patin (Fonderie de Precision de Nanterre, France); "Finishes for Die-castings," by A. P. Fenn (Birmingham Aluminium Casting (1903), Limited) and L. A. J. Lodder (Imperial Smelting Corporation, Limited), and "Productivity and Pressure-die-casting," by F. G. Woollard, chairman, Zinc Alloy Die Casters Association.

To open the conference, a film entitled "Die-casting—how else can you make it" was shown for the first time in Europe, and is now available for technical societies and schools. The film, which lasts 30 min., shows the production and use of die-castings in various metals and has been made jointly by the American Die Casting Institute and the American Zinc Institute. In conjunction with the conference, an exhibition of zinc-alloy die-castings is being held at the Birmingham Exchange and Engineering Centre, remaining open until November 6 (9 a.m. to 6 p.m.). Here, the film will be shown at 5 p.m. on November 2 and 5.



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Raw Material Markets

Iron and Steel

The furnaces in blast are well provided with raw materials and continue to obtain near-capacity outputs. The September output figures showed a decline of some 4,500 tons weekly, the chief reason being that fewer furnaces were in blast because of relining and repairs. In this reduction an appreciable tonnage of high-phosphorus foundry pig-iron was involved. From the record output of steel ingots during the month, the supply of basic steelmaking iron to the steelworks appears to have been maintained.

One of the furnaces out of production in the Derbyshire area for relining has been blown in again, while another one is expected to be brought into commission once more at the end of the month. It is expected that both these furnaces will be burdened for the production of high-phosphorus pig-iron, used chiefly by the light, jobbing, and textile foundries. Many of these foundries are not heavily employed, and they appear to have little difficulty at present in acquiring sufficient pig-iron for current consumption requirements. Although during the last week or so there has been an increased demand from these foundries, the tonnages taken up are on a fluctuating scale, and unless there is an improvement on present demands the position would suggest that there will be an excess in production over demand when more furnaces are producing this grade of pig-iron.

A contrary position is found at the engineering and speciality foundries. These establishments are receiving big demands for castings from many sources, particularly from the motor and allied trades, machine-tool makers, heavy electrical and power-plant equipment makers, collieries, steelworks, and others. Outputs of castings are controlled by the amount of pig-iron they can obtain. These foundries are very short of the low- and medium-phosphorus irons, and present production appears inadequate to provide fully for their needs. Large tonnages of hematite are being used by them and some quantities of refined iron. From some quarters hematite is scarce, particularly in the higher silicon ranges.

Scrap supplies generally are adequate to meet current needs, although there continues to be a good demand for heavy-machinery and cast-iron scrap. Foundry coke is coming forward fairly satisfactorily and supplies of ganister, limestone, and firebricks are obtained.

The re-rollers of steel are very busy and many of them have sufficient orders on hand to keep them fully employed until the turn of the year. Activity in heavy finished-steel products also is maintained and the demand for sheets is so great that only with difficulty are fresh orders placed.

Non-ferrous Metals

Figures issued by the Copper Institute in New York show that in September strikes had their effect on production in the United States. While the output of crude copper was 68,600 short tons, against 61,600 tons in August, production of refined in September, at 87,600 tons, compared with 103,900 tons in the previous month.

Deliveries to domestic consumers also declined, the September figure, at 89,000 tons, being some 3,500 tons down on the August total. Stocks of refined copper in producers' hands at September 30 were no more than 47,700 tons, a drop of 10,700 tons on the August figure and obviously much too low for safety.

Outside the U.S., production of crude was about 2,000 tons up, at 125,600 tons, while the output of refined rose by 7,000 tons to 107,500 tons. Deliveries of refined copper to consumers amounted to 110,200 tons, an increase of 6,800 tons on the revised August figure of 103,400 tons. Stocks of refined copper, at 172,000 tons, were virtually unchanged from those at August 31.

Business in the U.K. was decidely quiet last week; the dock strikes had an increasingly crippling effect on trade, many factories having to consider the possibility of a shutdown. There is a rumour that representations have been made to the Government for the release of copper from national stocks. So far as the price was concerned, both cash and three months gained £5 on the week, the backwardation remaining at £15. In the States there were daily fluctuations on the Commodity Exchange, but the export quotation came down to 32 cents, f.a.s. Little or nothing is being offered by Chile and it is doubtful whether much copper, either prompt or forward, can be bought from the United States.

Zinc was erratic on the London Metal Exchange, finishing 15s. down for second half October and 30s. lower for second half January. Due, probably, to the end of month tightness, a backwardation of 15s. appeared. Lead was unchanged prompt and down 15s. forward. Tin gained £2 for cash and lost £1 three months.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* October 21, £267 10s. to £269; October 22, £267 10s. to £270; October 25, £270 to £272 10s.; October 26, £280 to £282 10s.; October 27, £280 to £282 10s.

Three Months: October 21, £255 10s. to £256; October 22, £254 10s. to £255; October 25, £257 to £257 10s.; October 26, £261 10s. to £262; October 27, £260 to £261.

TIN, Standard—*Cash:* October 21, £732 to £732 10s.; October 22, £734 to £735; October 25, £732 10s. to £734; October 26, £729 to £730; October 27, £728 10s. to £729.

Three Months: October 21, £731 to £732; October 22, £732 10s. to £733; October 25, £731 to £731 10s.; October 26, £727 10s. to £728; October 27, £728 to £728 10s.

ZINC—*Second half October:* October 21, £82 15s. to £83; October 22, £82 to £82 5s.; October 25, £82 to £82 5s.; October 26, £80 15s. to £81; October 27, £81 10s. to £81 15s.

Second half January: October 21, £82 to £82 10s.; October 22, £81 5s. to £81 10s.; October 25, £81 5s. to £81 10s.; October 26, £80 10s. to £80 15s.; October 27, £81 to £81 5s.

LEAD—*Second half October*: October 21, £107 to £108; October 22, £107 5s. to £107 15s.; October 25, £107 15s. to £108; October 26, £110 to £111; October 27, £110 to £110 5s.

Second half January: October 21, £102 10s. to £102 15s.; October 22, £102 to £102 5s.; October 25, £102 5s. to £102 10s.; October 26, £102 10s. to £103; October 27, £103 to £103 5s.

THE MINISTRY OF HOUSING AND LOCAL GOVERNMENT has allowed an appeal by Mr. W. F. Taylor against the refusal of the Halesowen Town Council to allow him to use a building at Nimmings Road, Cakemore, as a patternmakers' workshop. The Minister has allowed its use for patternmaking for 10 years, provided it is not used for any other purpose and that machines are not operated on Sundays, or before 7 a.m. and after 6 p.m. on weekdays.

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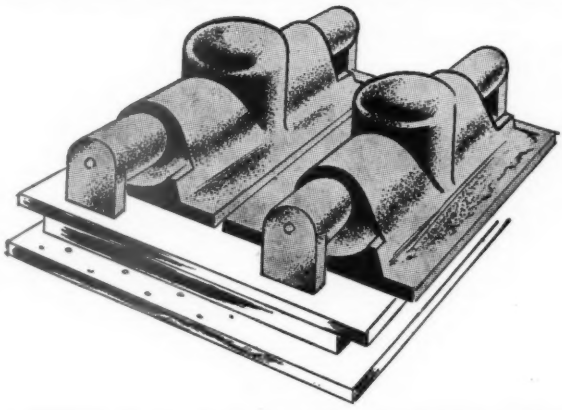

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Current Prices of Iron, Steel, and Non-ferrous Metals

(*Delivered unless otherwise stated*)

October 27, 1954

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £14 19s. 6d.; Birmingham, £14 12s. 9d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £17 5s. 9d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £17 16s. 9d.

Scotch Iron.—No. 3 foundry, £17 9s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £18 19s. 6d.; South Zone, £19 2s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £19 19s. 6d.; South Zone, £20 2s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £17 14s. 6d.; Scotland (Scotch iron), £18 1s. 0d.; Sheffield, £18 19s. 0d.; Birmingham, £19 6s. 6d.; Wales (Welsh iron), £18 1s. 0d.

Basic Pig-iron.—£15 10s. 6d. all districts.

FERRO-ALLOYS

(*Per ton unless otherwise stated, delivered*)

Ferro-silicon (6-ton lots).—40/55 per cent., £42 0s. 0d., basis 45 per cent. Si, scale 17s. per unit; 70/84 per cent., £65 0s. 0d., basis 75 per cent. Si, scale 18s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 10s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £185 0s. 0d. to £195 0s. 0d. per ton; 38/40 per cent., £251 0s. 0d. to £270 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent., 14s. 0d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 17s. 0d. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent. C, £75 0s. 0d. to £80 0s. 0d., basis 60 per cent. Cr, scale 25s. 0d. per unit; over 6 per cent. C, £74 0s. 0d. to £76 0s. 0d., basis 60 per cent. Cr, scale 24s. 0d. per unit; 2 per cent. C,* 1s. 7½d. per lb. Cr; 1 per cent. C,* 1s. 8d. per lb. Cr; 0.15 per cent. C,* 1s. 9½d. per lb. Cr; 0.10 per cent. C,* 1s. 9¾d. per lb. Cr; 0.06 per cent. C,* 1s. 10d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 6s. 6½d. to 7s. 1d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £225 0s. 0d. to £232 0s. 0d. per ton; 96/98 per cent., £255 0s. 0d. to £262 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 52s. 6d. to 70s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £54 15s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £25 12s. 6d.; tested, 0.08 to 0.25 per cent. C, £26 12s. 6d.; hard (0.41 to 0.60 per cent. C), £28 0s. 0d.; silico-manganese, £33 16s. 0d.; free-cutting, £28 16s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £32 12s. 0d.; silico-manganese, £34 17s. 6d.

* Average 68-70 per cent. Cr.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £29 16s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 0s. 0d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £31 1s. 6d.; boiler plates (N.-E. Coast), £32 9s. 0d.; floor plates (N.-E. Coast), £32 10s. 6d.; sectional material, N.-E. Coast, £29 4s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £32 7s. 0d.; flats, 5 in. wide and under, £32 7s. 0d.; hoop and strip, £33 9s. 0d.; black sheets, 17/20 g., £42 1s. 0d.; galvanized corrugated sheets, 24 g., £51 8s. 6d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £53 8s. 0d.; nickel-chrome, £75 2s. 0d.; nickel-chrome-molybdenum, £84 13s. 6d.

NON-FERROUS METALS

Copper.—Cash, £280 0s. 0d. to £282 10s. 0d.; three months, £260 0s. 0d. to £261 0s. 0d.; settlement, £282 10s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 31½d. per lb.; wire, 302s. 9d. per cwt. basis; 20 s.w.g., 334s. 0d. per cwt.

Tin.—Cash, £728 10s. 0d. to £729 0s. 0d.; three months, £728 0s. 0d. to £728 10s. 0d.; settlement, £729 0s. 0d.

Zinc.—Second half October, £81 10s. 0d. to £81 15s. 0d. second half January, £81 0s. 0d. to £81 5s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £112 10s. 0d.; rolled zinc (boiler plates), all English destinations, £110 5s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £96 0s. 0d.

Lead (Refined Pig).—Second half October, £110 0s. 0d. to £110 5s. 0d.; second half January, £103 0s. 0d. to £103 5s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 25½d. per lb.; rods, drawn, 34½d.; sheets to 10 w.g., 278s. 9d. per cwt.; wire, 32½d.; rolled metal, 265s. 0d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £190; B6 (85/15), £245; BS249, £197.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £219; HTB2 (38 tons), £228; HTB3 (48 tons), £236.

Gunmetal.—RCH, 3/4 per cent. tin, — ; BS1400, LG2 (85/5/5/5), £237; LG3 (86/7/5/2), £248; G1 (88/10/2/½), £321; (88/10/2/1), £311.

Phosphor Bronze.—BS1400, PB1 (AID released), £331 per ton.

Phosphor Bronze Strip, etc.—Strip, 391s. 9d. per cwt.; sheets to 10 w.g., 414s. 3d. per cwt.; wire, 48½d. per lb.; rods, 42½d.; tubes, 40¾d.; chill cast bars: solids 43d., cored 44d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 4d. per lb.; round wire, 10g. in coils (10 per cent.), 3s. 9½d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 3s. 8½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 3d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £110 0s. 0d. Nickel, £483 0s. 0d. Aluminium, ingots, £156 0s. 0d.; aluminium bronze (BS1400), AB1, £282; AB2, £290. Solder, brazing, BS1845, 2s. 3d. lb.; granulated. 2s. 6d. lb.

Forthcoming Events

NOVEMBER 1

Institute of British Foundrymen

Sheffield branch:—"Castings *v.* Fabrications," by H. Nottram, 7.15 p.m., at the College of Technology, Pond Street.

NOVEMBER 2

Fulmer Research Institute

Open day. By invitation only.

Institution of Production Engineers

Halifax section:—"Shell-moulding Process," by D. N. Buttrey, 7.15 p.m., at the White Swan Hotel Halifax.

Nottingham section:—"Costing and Measurement of Productivity," by W. Coutts Donald, 7 p.m., at the Welbeck Hotel, Milton Street.

Institute of Metals

Oxford local section:—"Ceramics," by Dr. J. White, 7 p.m., at the Cadena Cafe, Cornmarket Street.

Purchasing Officers' Association

Slough and district branch:—"Letting Off Steam," film by Crane Limited, 7.30 p.m., at the Reindeer Inn.

NOVEMBER 3

Incorporated Plant Engineers

Leicester branch:—"Process and Industrial Heating," by J. C. Edwards, 6.30 p.m., at the Leicester College of Art and Technology, The Newarkes.

Southampton branch:—"Maintenance Costs," by H. E. Baker, and "Steam Costs," by E. C. Rogers 7.30 p.m., at the Polygon Hotel.

Institution of Production Engineers

Peterborough section:—"Motion and Time Study," by Miss Anne G. Shaw, 7.30 p.m., at the Campbell Hotel, Bridge Street.

Institute of British Foundrymen

Lancashire branch:—"Aspects of High-duty Cast Iron and Is Green-sand Moulding Deteriorating?" by C. R. van der Ben and H. Haynes, 7 p.m., at the Engineers' Club, Albert Square, Manchester.

NOVEMBER 4

Incorporated Plant Engineers

Peterborough branch:—"Metal Spraying," by W. E. Ballard, 7.30 p.m., at the Eastern Gas Board's Demonstration Theatre, Church Street.

Institute of Metals

Birmingham local section:—"Metallurgical Research in the Electrical Industries," by Ivor Jenkins, 6.30 p.m. at the James Watt Memorial Institute, Great Charles Street.

Institution of Production Engineers

Glasgow section:—Open discussion evening, 7.30 p.m., at the Institute of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

Gloucester and district section:—"Productivity," by F. L. Daniels, 7.15 p.m., at the Bell Hotel, Gloucester.

Reading section:—"Developments in Work Study," by N. A. Dudley, 7.30 p.m., at Petters Limited, Causeway Works, Staines, Middlesex.

Recent Wills

DOUGAN, JOHN, chief roll designer of Skinningrove Iron Company, Limited, Saltburn-by-the-Sea (Yorks) £1,634

YOUNG, JAMES, chairman of W. H. Arnott, Young & Company, Limited, iron and steel merchants, etc., of Glasgow £18,461

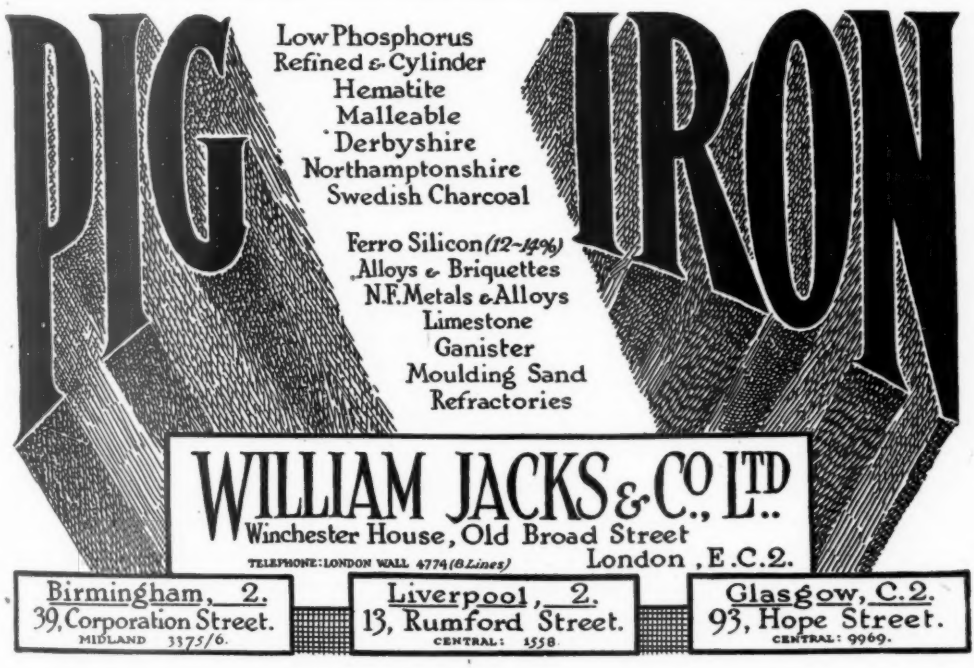
SEAL, W. H., joint managing director of Ham Baker & Company, Limited, iron and brass founders, of Birmingham £14,178

GREENHOUGH, C. E., works superintendent of the Patent Shaft & Axletree Company, Limited, Wednesbury (Staffs) £3,468

KENNEDY, ROBERT, a former director of Glenfield & Kennedy, Limited, hydraulic engineers and founders, of Kilmarnock (Ayr) £62,240

LIGHTBODY, ALEXANDER, managing director of C. F. Wilson & Company (1932), Limited, land and marine Diesel engine manufacturers, of Aberdeen £7,026

HOWARTH, DR. O. J. R., secretary of the British Association for the Advancement of Science, 1909-46, and president of the Geographical Association, 1953 ... ... £24,577



CLASSIFIED ADVERTISEMENTS

PREPAID RATES: Twenty words for 5s. (minimum charge) and 2d. per word thereafter. Box Numbers 2s. extra (including postage of replies).

Advertisements (accompanied by a remittance) and replies to Box Numbers should be addressed to the Advertisement Manager, Foundry Trade Journal, John Adam House, 17/19, John Adam Street, Adelphi, London, W.C.2. If received by first post Tuesday advertisements can normally be accommodated in the following Thursday's issue.

SITUATIONS WANTED

MANAGER (45), fully experienced Foundry Manager, seeks really progressive position. Practical man; sales, commercial, technical control. Engineering, machine tool, jobbing, mechanised plant production; experimental work in shell process.—Box MF827, FOUNDRY TRADE JOURNAL.

ASSISTANT FOUNDRY MANAGER, 28, of foundry producing 200 tons light/medium iron castings per week, wishes to become associated with a company requiring a man with wide experience, ability and unbounded enthusiasm. Salary to be based strictly on results. Box A.F.856, FOUNDRY TRADE JOURNAL.

ASSISTANT FOUNDRY ENGINEER (25), seeks position as assistant foundry manager in Liverpool/Manchester area. Drawing and foundry office experience. Five years' practical training in pattern shops, foundries, mechanized and heavy floor work. Higher National Certificate, Mechanical Engineering. At present employed by consulting engineers.—Box AF 862, FOUNDRY TRADE JOURNAL.

EXECUTIVE, specialising in Shot-blast Plant of the Impeller type, seeks similar position with a progressive firm desirous of widening its scope. Can bring the manufacturing and selling rights for G.B. and certain other countries of plant of advanced Continental design.—Box ES758, FOUNDRY TRADE JOURNAL.

METHODS ENGINEER, A.M.I.B.F., 14 years' supervision, seeks position. Practical foundryman, extensive experience mechanized and jobbing production. Thorough knowledge aluminium and bronzes. A.I.D. Time and Motion Study.—Box ME850, FOUNDRY TRADE JOURNAL.

PATTERNMAKER (35), A.M.I.B.F., at present employed in safe but dead-end job, seeks position where initiative is not frowned upon, preferably on foundry side. Twenty years' experience of wood and metal patternmaking of all types for floor and machine moulding. Sound practical experience of all foundry departments in the production of iron and non-ferrous castings. Jobbing foundry and mechanized plant. Willing to go anywhere, home or abroad, providing position offers scope for advancement on proven ability.—Box PA838, FOUNDRY TRADE JOURNAL.

FOUNDRY EXECUTIVE (31), 15 years' iron foundry experience, several years' executive experience. Qualified metallurgist, wide experience cupola, metal, sand and labour control. Sound practical training and progressive outlook. Accustomed full control, desires post where initiative, enthusiasm and integrity welcomed. West Midlands preferred or elsewhere if help forthcoming with accommodation. Please reply in confidence to Box FE853, FOUNDRY TRADE JOURNAL.

SITUATIONS WANTED—*contd.*

FOUNDRYMAN (31), requires position as Foundry Manager. Leeds-Keighley area preferred. Technical and supervisory experience in grey and high duty iron-foundry. Quality and profit-minded.—Box FR875, FOUNDRY TRADE JOURNAL.

YOUNG FOUNDRYMAN (30), desires change. A.M.I.B.F., full Tech. Cert., City and Guilds, foundry practice and science, Inter. Metallurgy. Experience at controlling labour. Anything considered relating to Foundry Industry, provided post is progressive. London area preferred.—Box YF874, FOUNDRY TRADE JOURNAL.

FOUNDRY METALLURGIST (28), Metallurgy Diploma, Melbourne Technical College; 12 years' experience, latterly Chief Metallurgist Australian foundry in charge laboratory, cupolas, D.A. furnace and sand control. Two years' experience production S.G. iron. Arrives Britain October to gain further experience. Available for one year's employment.—Replies to Box FM760, FOUNDRY TRADE JOURNAL.

MECHANICAL and Electrical Foundry MAINTENANCE ENGINEER desires change, 40 years of age, life experience in Modern Plants Well versed on heavy plants, workshop supervision and developments, 15 years of Executive Experience. Box MA832, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 *inclusive or a woman aged* 18-59 *inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order,* 1952.

WANTED.—Energetic man, about 30 years of age, with good education and engineering training, for the position of FOUNDRY PRODUCTION ASSISTANT. Applicants should hold a National Certificate or equivalent proof of technical education and ability, and should preferably have some knowledge of foundry work, though initiative and drive are regarded as the most important qualities.—Apply in own handwriting, giving details of experience to date and salary required, to: FOUNDRY ENGINEER, Morris Motors, Ltd., Nuffield Foundry, Wellingborough.

METHODS ENGINEER of Executive standing required by modern Steel Foundry. Experience in high alloy steels, shell moulding, etc., would be an advantage. Excellent prospects for right man and superannuation scheme in operation. Assistance with housing if required.—Write, stating age, experience and salary required, to PERSONNEL OFFICER, Sheepbridge Alloy Castings, Ltd., Hamilton Road, Sutton-in-Ashfield, Notts.

SITUATIONS VACANT—*contd.*

REPRESENTATIVE for Southern area with proved sales record, capable of earning £800 or more, required for Non-Ferrous foundry—good prospects. Please state age, experience, etc., to Box RF871, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN required for Blackheart Malleable Foundry in Midlands. Output 15 tons weekly. Must be fully conversant with all foundry practice. Full control given. State qualifications and salary required. Box FF833, FOUNDRY TRADE JOURNAL.

MANAGER required for small Sand Foundry in South Birmingham Area engaged in high class production in aluminium and copper base alloys. Good salary for right man, age 30-45 years.—Box MR846, FOUNDRY TRADE JOURNAL.

MECHANIC required, with experience of "B.M.M." Moulding Machines, to service an installation of 32 Turnover and Straight draw type machines in a South African Foundry. Replies to Box MR873, FOUNDRY TRADE JOURNAL.

METAL PATTERNMAKERS required with Toolroom experience for new Factory Southern Counties. Housing accommodation available. Highest rates. First Class men only need apply. UNIVERSAL PATTERN CO. (LONDON) LTD., 269, Rotherhithe New Road, London, S.E.16.

METAL PATTERNMAKER — WORKING CHARGE HAND REQUIRED —with Machine Experience and fully conversant Layout and Planning, for new Factory in Southern Counties. Housing accommodation available. Highest Rates. UNIVERSAL PATTERN CO. (LONDON) LTD., 269, Rotherhithe New Road, S.E.16.

CINCINNATI DIE MILLER OPERATOR required. Fully experienced, for new Factory in Southern Counties. Rate 5s. 6d. Permanent position for the right man. Housing accommodation available. UNIVERSAL PATTERN CO. (LONDON) LTD., 269, Rotherhithe New Road, S.E.16.

SENIOR PRODUCTION CONTROL CLERK required. Experience in machine loading for mechanised foundry desirable. Applicants must be capable of drawing up complete programmes and organising progress. Prospects of eventual control of section are envisaged. Commencing salary £575 per annum. Apply Personnel Manager, Box SP831, FOUNDRY TRADE JOURNAL.

ASSISTANT FOUNDRY FOREMAN required at once by a progressive modern non-ferrous foundry in the Home Counties, producing 10 tons upwards per week of high quality precision castings. Opening for a young man aged about 25-30 who requires a permanent position. Must have had sound practical foundry experience in the production of precision and high-class light- to medium-weight castings and capable of supervising both mechanized plant and floor moulding production. Must be progressive in outlook and with a knowledge of modern techniques. Applications in confidence stating age, experience, and salary required to Box AF843, FOUNDRY TRADE JOURNAL.